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Second Annual Meeting, Champaign, Ill., Nov. 11–13, 1890. (The same officers had charge of this meeting.)

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Fourth Annual Meeting, Rochester, N. Y., Aug. 15–16, 1892. President, J. A. Lintner; First Vice-President, S. A. Forbes; Second Vice-President, J. H. Comstock; Secretary, F. M. Webster.

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Sixth Annual Meeting, Brooklyn, N. Y., Aug. 14–15, 1894. President, L. O. Howard; First Vice-President, John B. Smith; Second

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Eighth Annual Meeting, Buffalo, N. Y., Aug. 21–22, 1896. President, C. H. Fernald; First Vice-President, F. M. Webster; Second Vice-President, Herbert Osborn; Secretary, C. L. Marlatt.

Ninth Annual Meeting, Detroit, Mich., Aug. 12–13, 1897. President, F. M. Webster; First Vice-President, Herbert Osborn; Second Vice-President, Lawrence Bruner; Secretary, C. L. Marlatt.

Tenth Annual Meeting, Boston, Mass., Aug. 19–20, 1898. President, Herbert Osborn; First Vice-President, Lawrence Bruner; Second Vice President, C. P. Gillette; Secretary, C. L. Marlatt.

Eleventh Annual Meeting, Columbus, Ohio, Aug. 18–19, 1899. President, C. L. Marlatt; First Vice-President, Lawrence Bruner; Second Vice-President, C. P. Gillette; Secretary, A. H. Kirkland.

Twelfth Annual Meeting, New York, N. Y., June 22–23, 1900. President, Lawrence Bruner; First Vice-President, C. P. Gillette; Second Vice-President, E. H. Forbush; Secretary, A. H. Kirkland.

Thirteenth Annual Meeting, Denver, Colo., Aug. 23–24, 1901. President, C. P. Gillette; First Vice-President, A. D. Hopkins; Second Vice-President, E. P. Felt; Secretary, A. L. Quaintance.

Fourteenth Annual Meeting, Pittsburg, Pa., June 27–28, 1902. President, A. D. Hopkins; First Vice-President, E. P. Felt; Second Vice-President, T. D. A. Cockerell; Secretary, A. L. Quaintance.

Fifteenth Annual Meeting, Washington, D. C., Dec. 26–27, 1902. President, E. P. Felt; First Vice-President, W. H. Ashmead; Second Vice-President, Lawrence Bruner; Secretary, A. L. Quaintance.

Sixteenth Annual Meeting, St. Louis, Mo., Dec. 29–31, 1903. President, M. V. Slingerland; First Vice-President, C. M. Weed; Second Vice-President, Henry Skinner; Secretary, A. F. Burgess.

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Eighteenth Annual Meeting, New Orleans, La., Jan. 1–4, 1906. President, H. Garman; First Vice-President, E. D. Sanderson; Second Vice-President, F. L. Washburn; Secretary, H. F. Summers.

Nineteenth Annual Meeting, New York, N. Y., Dec. 28–29, 1906. President, A. H. Kirkland; First Vice-President, W. E. Britton; Second Vice-President, H. A. Morgan; Secretary, A. F. Burgess.

Twentieth Annual Meeting, Chicago, Ill., Dec. 27–28, 1907. President, H. A. Morgan; First Vice-President, H. E. Summers; Second Vice-President, W. D. Hunter; Secretary, A. F. Burgess.

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Proceedings of the Twentieth Annual Meeting of the Association of Economic Entomologists

The twentieth annual meeting of the Association of Economic Entomologists was held at the University of Chicago, Chicago, Illinois, December 27 and 28, 1907.

For convenience the report has been prepared in two parts, the first being devoted to the business transacted and the second containing the addresses, papers and discussions.

PART I

The meeting was called to order by President Morgan at 10 a. m., Friday, December 27, in Room 24, Zoölogy Building. The average number of members and visitors present during the meeting was ninety. The members attending were as follows:

C. E. Bartholomew, Ames, Iowa; G. M. Bentley, Knoxville, Tenn.; F. C. Bishopp, Washington, D. C.; W. E. Britton, New Haven, Conn.; F. E. Brooks, Morgantown, W. Va.; C. T. Brues, Milwaukee, Wis.; Lawrence Bruner, Lincoln, Neb.; A. F. Burgess, Washington, D. C.; R. S. Clifton, Washington, D. C.; Mel. T. Cook, Newark, Del.; E. C. Cotton, Knoxville, Tenn.; J. J. Davis, Urbana, Ill.; E. B. Engle, Harrisburg, Pa.; E. P. Felt, Albany, N. Y.; H. T. Fernald, Amherst, Mass.; James Fletcher, Ottawa, Canada; S. A. Forbes, Urbana, Ill.; G. H. French, Carbondale, Ill.; A. A. Girault, Urbana, Ill.; B. H. Guilbeau, Baton Rouge, La.; C. A. Hart, Urbana, Ill.; T. J Headlee, Manhattan, Kan.; W. E. Hinds, Auburn, Ala.; W. A. Hooker, Washington, D. C.; L. O. Howard, Washington, D. C.; W. D. Hunter, Washington, D. C.; Fred Johnson, Washington, D. C.; H. A. Morgan, Knoxville, Tenn.; Henry Ness, Ames, Iowa; Wilmon Newell, Baton Rouge, La.; J. F. Nicholson, Stillwater, Okla.; Herbert Osborn, Columbus, Ohio; Edith M. Patch, Orono, Me.; E. F. Phillips, Washington, D. C.; J. L. Phillips, Blacksburg, Va.; W. D. Pierce, Washington, D. C.; A. L. Quaintance, Washington, D. C.; W. A. Riley, Ithaca, N. Y.; A. G. Ruggles, St. Anthony Park, Minn.; W. E. Rumsey, Morgantown, W. Va.; J. G. Sanders, Washington, D. C.; E. D. Sanderson, Durham, N. H.; E. R. Sasscer, Washington, D. C.; Franklin Sherman, Jr., Raleigh, N. C.; J. B. Smith, New Brunswick, N. J.; R. I. Smith, Raleigh, N. C.; H. E. Summers, Ames, Iowa; T. B. Symons, College Park, Md.; E. P. Taylor, Mountain Grove, Mo.; James Troop, Lafayette, Ind.; R. A. Vickery, St.

Anthony Park, Minn.; F. L. Washburn, St. Anthony Park, Minn.; R. L. Webster, Urbana, Ill.; J. A. West, Urbana, Ill.; H. E. Weed, Chicago, Ill., and E. L. Worsham, Atlanta, Ga.

The following visitors were present:

C. C. Adams, Chicago, Ill.; G. G. Ainslie, St. Anthony Park, Minn.; J. C. Bradley, Ithaca, N. Y.; C. R. Crosby, Ithaca, N. Y.; J. R. Field, Boise, Idaho; J. C. Hambleton, Columbus, Ohio; J. D. Hood, Urbana, Ill.; P. L. Huested, Blauvelt, N. Y.; E. J. Kraus, Washington, D. C.; H. H. Lyman, Montreal, Canada; J. F. McClendon, Columbia, Mo.; J. G. Needham, Ithaca, N. Y.; L. M. Smith, Urbana, Ill.; L. R. Taft, Lansing, Mich.; Mrs. E. P. Taylor, Mountain Grove, Mo., and H. F. Wilson, Urbana, Ill.

The American Association of Nurserymen was represented by its President, Mr. J. W. Hill, Des Moines, Iowa, and by Col. C. L. Watrous, Des Moines, Iowa, Prof. John Craig, Ithaca, N. Y., and Mr. Orlando Harrison, Berlin, Md.

President Morgan called First Vice-President Summers to the chair while he presented the annual address.

The report of the Treasurer was read and referred to the auditing committee.

The Secretary reported that as no program committee was appointed at the last meeting, he had made up the final program and it had been printed and distributed. He also reported for the committee appointed at the last meeting to prepare and forward certificates of membership to the foreign members, and stated that this had been done. Several acknowledgments were read to the Association showing that the certificates had been received and were greatly appreciated.

The Secretary stated that he had made an attempt to codify the constitution, in accordance with a resolution passed at the last meeting, but found it very difficult to do so on account of several contradictory amendments. He therefore suggested that a special committee be appointed to revise the constitution and report, so that action could be taken at the next annual meeting.

By vote of the Association the report of the Secretary was accepted.

On motion it was voted that the chair appoint a committee of three to revise the constitution.

The Secretary read a list of proposals for membership which he had received and it was referred to the committee on membership. He also reported that the following members of the Association had resigned during the year: J. M. Aldrich, Moscow, Idaho; H. P. Gould, Washington, D. C., and Gerald McCarthy, Raleigh, N. C.

In view of the distinguished work which is being done in Crimea by Prof. Sigismond Mokshetsky, whose name had been proposed by Dr.

Howard, it was moved and carried that, as a special honor, he be elected a foreign member without the formality of having his name referred to the membership committee.

The President announced the appointment of the following committees:

Membership—Messrs. Summers, J. B. Smith and Forbes.
Resolutions—Messrs. W. D. Hunter, Washburn and Sanderson.
Nominations—Messrs. Osborn, Felt and Newell.
Auditing—Messrs. Sherman and Fernald.
Constitution—Messrs. Burgess, J. B. Smith and Symons.

As the standing committees elected at the last annual meeting were not ready to report, no further business was transacted until the afternoon session.

On motion of Mr. Symons, it was voted that the representatives of the American Association of Nurserymen, who had been invited to attend the meeting, be given the privileges of the floor.

Mr. Newell, the representative of the Association of Economic Entomologists on the joint committee on national control of introduced insect pests, presented the following report:

To the Association of Economic Entomologists:

At the last annual meeting, this Association elected one member to act on a joint committee on legislation, to be composed of one member each from the Association of Economic Entomologists, the American Association of Nurserymen and the Association of Official Horticultural Inspectors.

The members of this joint committee have been in correspondence with each other during the year and have today held a meeting at which a definite plan for securing uniformity in the certification of interstate shipments of nursery stock, has been decided upon. While this committee was elected with power to take all advisable action toward the end in view, nevertheless, the members feel that if the plan now decided upon by them be formally approved by the entire Association of Economic Entomologists, the legislation in view will be much more easily secured.

The committee asks your endorsement of the following plan of procedure:

A—Resolved, That the Secretary of Agriculture should be empowered to make regulations governing importations liable to harbor insect pests or plant diseases; to require such importations to be accompanied by a certificate of a duly accredited entomologist of the country in which said shipments originate, or, in the absence of such a certificate, to make inspections of such shipments, by competent agents, at the point of destination, and that sufficient appropriation should be made for this purpose by Congress.

B—1. That Congress be asked to enact a law empowering the Secretary of Agriculture to issue certificates of nursery inspection, as nearly uniform as possible, to all nurseries in the United States engaging in interstate trade, upon proper inspection of such nurseries by duly authorized representatives of the United States Department of Agriculture, or by State officials approved by the Secretary of Agriculture for that purpose, and that sufficient appropriation be made therefor.

2. That all state or territorial officials in charge of nursery inspection be urged to accept these certificates at their face value, and that in states where laws are now in force which will not allow the acceptance of such certificates, the inspection departments be requested to endeavor to secure such state legislation as will make this possible.

C—That Congress should authorize the Secretary of Agriculture to proceed to exterminate or control imported insects or plant diseases, or any insect previously native to a restricted locality, but which may become migratory and threaten the whole country, whenever in his judgment such action is practicable, and that an appropriation be made for this purpose as a reserve fund for emergency use against any such pest which may arise.

The joint committee proposes to have two bills prepared for introduction into Congress; one of these embracing the subject matter of sections A and B, and the other embracing only the subject matter of section C, and that if the passage of both measures be found impracticable or impossible then all efforts be concentrated in the attempt to secure the passage of the bill involving the certification and inspection of imports and the control of nursery stock shipments entering into interstate trade, as above outlined.

Respectfully submitted,

WILMON NEWELL,
Member of Joint Committee.

It was moved and seconded that the report be received and that the recommendations of the committee be endorsed by the Association.

Mr. J. B. Smith favored laying the report on the table until it could be more thoroughly examined by the members, as he considered it unwise to take hasty action on the matter.

In reply Mr. Newell stated that the report is practically the same as that endorsed by the Association at the last annual meeting. The reason for desiring immediate action was that a number of the representatives of the nurserymen were obliged to leave the city that evening and, as they desired to have a bill drafted at once for presentation to Congress, they wished the further endorsement of the Association at this convention.

After a brief discussion the motion prevailed.

Mr. Hill, President of the American Association of Nurserymen, thanked the Association for the endorsement of the report and stated that the action taken would be of great assistance to the committee in securing the desired legislation.

The report of the Committee on Nomenclature was presented at the Saturday morning session as follows:

REPORT OF THE COMMITTEE ON NOMENCLATURE.

Your committee on nomenclature begs leave to report as follows:

First, that no additional list of names for final adoption is submitted at this meeting.

Second, that we recommend that the lists previously adopted be brought

together and published in full in the next proceedings, and also printed by the society in separate pamphlet form with a summary of actions concerning the use of common names adopted at previous meetings, for distribution to all members of the society, to agricultural journals, members of the Entomological Society of America and such other parties as the secretary and the committee on nomenclature may deem wise.

Third, that the use of these adopted names be again urged on all parties in publications of an economic character.

Your committee would also call attention to the action of the International Congress of Zoölogists in regard to the fixing of generic types, such action in substance being that a generic type once fixed or designated by whatever process is to stand as the type.

Respectfully submitted,

HERBERT OSBORN.
F. M. WEBSTER.

It was voted that the report be accepted and the recommendations adopted by the Association.

Mr. Sanderson presented a plan for publishing a journal on economic entomology. He stated that on the previous evening a number of the members who were interested in the matter had met and decided to form a company for the purpose, provided a satisfactory arrangement could be made for the journal to become the official organ of the Association. He presented a resolution in the form of an agreement for the consideration of the meeting. After some general discussion it was voted that the chair appoint a committee of three members to investigate the matter and report at the afternoon session.

The following committee was appointed: Messrs. J. B. Smith, Osborn and Bruner.

It was voted to make the reports of committees a special order of business, to be called up at 4.30 p. m., and that arrangements be made to hold a session at 8 p. m. to finish the reading of the papers remaining on the program.

At 4.30 p. m. the committee appointed to investigate the proposed journal of economic entomology presented its report, which endorsed the resolution presented at the morning session by Mr. Sanderson.

A brief discussion followed in which Mr. J. B. Smith called attention to the fact that this marked a complete change in the previous policy of the Association, and meant practically severing all connection with the United States Department of Agriculture. It might be a difficult matter to induce the Department to publish the annual report of the Association in the future, in case the journal should not be a financial success.

The report was amended in order to increase the advisory board

from five to six members, and to clearly define the method of their election, and it was then adopted by the Association in the following form:

That those hereto subscribing form a company for publishing a journal devoted to economic entomology, to be the official organ of the Association of Economic Entomologists; that this company will publish six issues a year of fifty to one hundred pages each, at a subscription price of one dollar ($1.00) to members and two dollars ($2.00) to non-members, in consideration of which the Association of Economic Entomologists agrees to publish its proceedings in said journal; that this company shall elect the editor and business manager, and that the advisory board shall consist of six members, to be nominated by the committee on nominations of the Association of Economic Entomologists and approved by the Association, which the company agrees to elect, two for one year, two for two years and two for three years, and that there shall hereafter be elected annually, in the same manner, two members to succeed those retiring; that the above-mentioned board with the editor and business manager shall determine the policy of the journal and shall control the matter published in it; that the subscription list for stock in the company shall be open to all members of the Association of Economic Entomologists, and to them only, at ten dollars ($10) per share, payable on demand.

The Committee on Membership presented the following report:

REPORT OF THE COMMITTEE ON MEMBERSHIP.

The Committee on Membership recommend the following:

For foreign members:

Prof. C. Gordon Hewett, Manchester, England, proposed by Dr. L. O. Howard.

Dr. Waldemar Pospielow, Station Entomologique, Rue de Boulevard No. 9, Kiew, Russia, proposed by Dr. L. O. Howard.

For transfer from associate to active membership:

Mr. R. C. L. Perkins, Honolulu, Hawaii.

For associate members:

Myron H. Swenk, University of Nebraska, Lincoln, Neb.

Harry S. Smith, University of Nebraska, Lincoln, Neb.

Paul R. Jones, Bureau of Entomology, Washington, D. C.

Henry Ness, Iowa State College, Ames, Iowa.

J. E. Buck, Agricultural Experiment Station, Blacksburg, Va.

R. A. Vickery, Agricultural Experiment Station, St. Anthony Park, Minn.

George A. Dean, Kansas Agricultural College, Manhattan, Kan.

Howard E. Weed, Chicago, Ill.

C. T. Paine, San José, Cal.

Charles Spooner, Agricultural Experiment Station, Durham, N. H.

B. H. Guilbeau, Baton Rouge, La.

George A. Runner, State Crop Pest Commission, Baton Rouge, La.

Arthur H. Rosenfeld, State Crop Pest Commission, Baton Rouge, La.

T. C. Barber, State Crop Pest Commission, Baton Rouge, La.

W. H. Goodwin, Agricultural Experiment Station, Wooster, Ohio.

Frederick B. Lowe, 6 Beacon Street, Boston, Mass.

H. O. Marsh, Bureau of Entomology, Washington, D. C.

J. A. West, Urbana, Ill.

Edith M. Patch, Agricultural Experiment Station, Orono, Me.

E. L. Worsham, Capitol Building, Atlanta, Ga.

Burton N. Gates, Bureau of Entomology, Washington, D. C.

Glen W. Herrick, Agricultural Experiment Station, Agricultural College, Miss.

John J. Davis, University of Illinois, Urbana, Ill.

To be dropped from membership (on account of having discontinued entomological work.)

J. M. Rankin, Leslie Martin, C. M. Walker, E. S. Hardy, W. O. Martin.

The committee further recommends:

That the committee on membership shall be appointed at the first session of each annual meeting, to serve until the appointment the next year of their successors, to whom the retiring committee shall transmit written recommendations concerning new members, promotions to active membership and names to be dropped from the roll.

The committee further recommends:

That the secretary be requested to have blanks printed for application for membership.

Respectfully submitted,

H. E. Summers,
J. B. Smith,
S. A. Forbes,
Committee.

By vote of the Association the report was accepted and the recommendations of the committee adopted.

The report of the Treasurer and of the Auditing Committee was as follows:

REPORT OF THE TREASURER.

Jan. 1–Dec. 27, 1907.	By amount received for dues		$111.00
Jan. 1, 1907.	To balance due on account of 1906	$16.40	
	paper and printing	5.00	
	express on manuscript	.55	
	stamps	1.00	
	printing	2.25	
	rent of typewriter	3.00	
April 20,	stamps	3.00	
" 25,	stamps	1.00	
May 1,	stamps	1.00	
" 24,	stamps	1.00	
Oct. 5,	stamps	4.00	
" 16,	printing certificates and blanks	12.25	
" 29,	express charges	.70	
Nov. 6,	mailing tubes	1.00	
" 15,	stamps	2.50	
" 16,	stamps	1.25	

Dec. 14,	stamps	4.00	
" 21,	telegram	.98	
	Total amount expended,	$60.88	
	To balance in the treasury, Dec. 27, 1907	50.12	
			$111.00

Respectfully submitted,
A. F. BURGESS, *Treasurer.*

The Auditing Committee reported that the accounts of the treasurer had been examined and that they were found correct, and that a record of auditing had been made in the treasurer's book.

FRANKLIN SHERMAN, JR.,
H. T. FERNALD,
Committee.

These reports were accepted by vote of the Association.

The report of the Committee on Nominations was next presented:

REPORT OF THE COMMITTEE ON NOMINATIONS.

Your committee to nominate officers for the year 1908 begs leave to report as follows:

For President, Dr. S. A. Forbes, Urbana, Ill.

For First Vice-President, Dr. W. E. Britton, New Haven, Conn.

For Second Vice-President, Dr. E. D. Ball, Logan, Utah.

For Secretary-Treasurer, A. F. Burgess, Washington, D. C.

For Member of the Committee on Nomenclature, Prof. A. L. Quaintance, Washington, D. C.

For Members of the Council A. A. A. S., Prof. H. A. Morgan, Knoxville, Tenn., and Dr. James Fletcher, Ottawa, Canada.

For Member of the Joint Committee, Wilmon Newell, Baton Rouge, La.

Respectfully submitted,
HERBERT OSBORN,
E. P. FELT,
WILMON NEWELL,
Committee.

On motion the Secretary was instructed to cast the ballot of the Association for the list of officers reported by the committee and they were declared elected.

The same committee also presented the names of the following members to serve on the advisory board of the journal:

For three years, Messrs. Howard and Forbes.

For two years, Messrs. Fletcher and Morgan.

For one year, Messrs. Fernald and Osborn.

By vote of the Association these nominations were approved.

The report of the Committee on Resolutions was presented as follows:

REPORT OF THE COMMITTEE ON RESOLUTIONS.

The committee begs leave to report as follows:

Resolved, That the Association of Economic Entomologists expresses its appreciation of the courtesies extended by the University of Chicago, the local committee on arrangements, and the entomologists of Chicago; and

Resolved, That this Association hereby expresses its gratitude to Dr. L. O. Howard, Chief of the Bureau of Entomology, and the Honorable Secretary of Agriculture, for the editing and publication of its proceedings since its organization, and whereas in the infancy of this organization a means of publication was furnished it by Insect Life, published by the Division of Entomology, that this Association trusts that the staff of the Bureau of Entomology will make free use of the Journal of Economic Entomology now to be instituted as the official organ of this Association; and

Resolved, That the Association beholds with gratification the recent activity in the study of ticks concerned in the transmission of diseases or that may be found to be so concerned and urges the members to make further and more extensive investigations in this important field; and

Resolved, That the Association recommend that apiculture receive more attention from the official state entomologists and especially that attention be paid to the distribution and treatment of the brood diseases of bees; and

Resolved, That the Association expresses its appreciation of the valuable work being done by Prof. A. L. Herrera, of the Mexican Comission de Parasitologia Agricola, under conditions of peculiar difficulty, and that the Secretary be instructed to notify Professor Herrera of this action; and

Resolved, That the Association reiterates its expression in the resolution passed at the New Orleans meeting to the effect that wherever possible the Secretary arrange programs on the symposium plan.

W. D. Hunter,
E. Dwight Sanderson,
F. L. Washburn,
Committee.

At the suggestion of Mr. Fletcher, the committee submitted a special resolution on the gypsy moth work as follows:

Resolved, That the Association heartily approves the work now being done in the control of the gypsy moth and brown-tail moth by the state of Massachusetts and other states and by the Bureau of Entomology; and inasmuch as we have heard of criticism of this work from certain quarters, we hereby express our unqualified approbation of the present management and of the methods which it has adopted, and furthermore we would consider a change in policy as most dangerous to the vital interests concerned in the most important work in applied entomology that has ever been undertaken.

In discussing this resolution Mr. Fletcher called attention to the excellent results that are being secured from this work, and urged the necessity of a continuance of the same management and policy that has brought about these results.

It was moved and carried that the report be adopted. The special resolution was then unanimously approved by the Association.

The Standing Committee on Insecticides submitted the following report:

REPORT OF THE STANDING COMMITTEE ON INSECTICIDES.

Your committee on insecticides begs to present the following report:

1. After consideration of the list of insecticides submitted to the members of the Association for testing as reported to the committee of last year on this subject (which list is herewith appended) it seems to your committee that it is not advisable at the present time to undertake any coöperative tests of any of them.

2. Your committee recommends that all new proprietary insecticides offered to members of this Association be referred to this committee, who will then proceed, as suggested in the report of the committee on this matter of last year, part two.

3. The committee believes that it should ascertain whether it is possible to secure an interpretation or amendment of the national pure food and drug law so that it will include insecticides and fungicides, and if this is found impossible that the committee draw up and report to the next meeting of this Association a suggested law which will aid in securing uniformity of legislation in the various states, as regards the compulsory analysis and labeling of insecticides and fungicides.

Respectfully submitted,

E. D. SANDERSON,
E. P. FELT,
H. E. SUMMERS,
R. I. SMITH.

The following is a list of insecticides submitted by the committee with the above report:

Arsenites: Swift's Arsenate of Lead, Green Death, Disparene, Green Arsenoid.

Scale insect remedies: Scalecide, Rex Lime Sulfur Wash, Target Brand Lime Sulfur Wash, Target Brand Scale Emulsion, Consol, Kil-o-Scale, Horicum.

Tobacco preparations: Rose Nicotine, Nikoteen, Rose Leaf Extract, Nicoticide, Tobacco Dust, Aphis Punk.

Larvacides: Phinotas Oil.

Tree Pastes: Tree Tanglefoot, Stone's Tree Paste, Borer Tanglefoot, Raupenleim.

Soaps: Takanap soap.

Miscellaneous: Zenoleum, Orient Spray, Limoid, American Disinfectant, Carlson's Mixture, Kerosene Flour Emulsion, Pearson's Creolin.

Voted that the report be adopted and the committee continued.

The Secretary asked for instructions from the Association in regard to limiting the length of time to be allowed for the presentation of papers at future meetings. After some general discussion the following motion was made and carried:

"That the Secretary in calling for titles be authorized to request a fifteen-minute limit for papers, at the same time not necessarily limiting the length of important papers to that time; and that the time desired by each author be stated when submitting his title."

At the evening session the President called attention to the desire of the representatives of the American Association of Nurserymen to have a committee appointed to attend their annual convention at Milwaukee.

It was voted that a committee of three be appointed by the chair. The following members were selected,—Messrs. Forbes, Burgess and Symons.

Mr. Orlando Harrison, representing the above mentioned Association, thanked the Association of Economic Entomologists for the courtesies extended to the nurserymen during the meeting.

Immediately before adjournment Mr. W. D. Hunter presented the resolution which follows:

Resolved, That the thanks of the Association be extended to the President, Prof. H. A. Morgan, for the equanimity, for the genial good nature, and for the wisdom with which he presided over the meetings of the twentieth annual session.

This resolution was put before the meeting by Mr. Hunter and received unanimous approval.

President Morgan expressed his appreciation of the sentiments conveyed in the resolution, and with his usual unselfishness attempted to show that the Secretary was responsible for the success of the meeting.

There being no further business the meeting adjourned.

PART II

The annual address of the President was presented at the opening session of the meeting, Friday morning, as follows:

THE RELATION OF THE ECONOMIC ENTOMOLOGIST TO AGRICULTURE

By H. A. Morgan, *Knoxville, Tenn.*

The discussions of the systematic, developmental, and purely economic aspects of the subject of Entomology that have been presented before this body from time to time have indicated in a conspicuous way the broad yet definite field of the economic entomologist. In the interest of the future work of the Association these general boundaries should be maintained, as it is difficult to predict just when or where even the most remote biologic investigation, discovery or observation

will thread its way into some definite economic problem, or when a commonly recognized condition will induce a purely scientific search for the unknown cause.

In selecting for discussion at this time the relation of the economic entomologist to agriculture, it is not my purpose to restrict the interpretation of this relation to that which prevailed nearly a quarter of a century ago, when this Association was instituted, but to point out that larger interpretation which the wave of interest in agricultural education and investigation justifies, and which will be realized unless misdirection from one cause or another shall materially affect the present tide. Agriculture is in need of the entomologist, and the entomologist has a fruitful field in agriculture.

In the United States the land-grant colleges, made possible by the Morrill Act, in 1862, sent out the first organized tracer after a lost agriculture. A study of the history of many of these colleges in the light of present agricultural conditions indicates that the men who were placed in charge of these initial institutions were oftentimes without an agricultural compass and, what is worse, were without the sympathy and support of the people for whom the effort was being made. Hence, there was much time lost in adjusting a modern movement to old-time conditions. Not until the Hatch Act was put into operation, and investigational work was set in motion, did the complex nature of agriculture begin to be apparent. Through independent efforts of pioneer entomologists in some of the states, entomology had already found a place in the agricultural schedule, and upon the organization of the state experiment stations, entomologists were placed on the staffs; or the subject had won sufficient recognition to be associated with departments of biology or horticulture, already a part of the colleges with which the stations were affiliated.

The relation of economic entomology to agriculture was recognized by the nation prior to 1887, and, while not specified in the Hatch Act, its real relation to a state's agriculture was no doubt a part of the general conception of the author of the bill which gave each state an institution for agricultural investigation.

Some of the colleges receiving the benefits of the Morrill Act were giving limited courses in entomology at the time the experiment stations were organized. In others the number of insect forms had given taxonomic value to the study of entomolgy in zoölogical courses; while in others the economic aspect of insects was incidentally emphasized by the horticulturist or agriculturist in connection with some orchard, garden, or field pest.

Are we not justified in concluding, then, that when the spirit of investigation became effective in agriculture, economic entomology re-

ceived its logical setting? This may be true of many other sciences entering into composite agriculture; yet the peculiar relation of entomology to agriculture is conspicuous. Were this not true, the rapid strides that have been made in associating the two would have been impossible.

You will agree with me that with economic entomology unsatisfactorily associated, its future imperfectly projected, and with meager means for the preparation of persons for the work, the pioneers of this science merit commendation not usually accorded them. It is true that many of the men who took positions as entomologists of experiment stations in the beginning were better prepared for many other lines of work, but the wealth of opportunity for observation and investigation, and their application of these to agricultural progress, could hardly be mistaken. Now and then errors of observation were made and recorded, some of which unfortunately have been perpetuated by quotation to this time. It was to be expected, too, that certain easy methods and successful lines should drift economic entomological thought and activity into definite directions and veil for a time the real value of biological as well as ecological investigations and their application to preventive and remedial relief. The biting and sucking mouth parts were for a time the only recognized parts of an insect's anatomy, and hellebore, Paris green, and coal oil emulsion the standard substances in insect warfare.

The conceptions of the scope of entomological research as related to agricultural development have gradually but surely been expanded, until now a worker in this field finds himself involved in problems of very much wider range than the superficial anatomy of a common insect enemy of a local crop, or the compounding of a standard insecticide. Insects are related to diseases of live stock, as hosts of sporozoic organisms and nematodes, or as disseminators of diseases of bacterial origin; the importing and distributing of predatory and parasitic forms, and the adjusting of these to new conditions and even new hosts; the exact relation of insects to fruit and seed development; and the interrelation of insects, as in the case of ants and aphids, are all modern problems of economic entomology. While these questions are associated, either directly or indirectly, with agriculture, and are of great importance, I wish at this time to consider to what extent the student of economic entomology, in order to apply his knowledge to the best advantage, should be also a student of agriculture.

Within recent years deep-seated problems in connection with the occurrence of insects and allied forms have given prominence to lines of investigation of unusual merit in point of results. During the past season the army worm again appeared in destructive numbers in many

portions of Tennessee. Some observations were made of well separated outbreaks to determine if possible the reason for the unusual attack. In most cases the system of crop rotation and the farm practice were found conducive to the protection of the wintering forms under suitable climatic conditions. In the latitude of Tennessee a general rotation is corn, wheat, meadow. During average seasons corn land, after what is termed the "laying by," becomes foul with weeds, particularly a species of Ambrosia. This land, after the wheat is cut the second year produces a heavy growth of weeds from seeds of the previous year. The weeds are cut and left as a mulch for the meadow. This mulch affords protection for the army worm during winter and early spring of the third season, which results, if a late spring obtains, in the destruction of the meadow crop and the spread of the worms into contiguous fields. These observations place the burden of proof for the outbreak upon the corn crop and the practices prevailing in its cultivation. Preventive measures must be sought in a change in the rotation and possibly in the introduction of a new crop. Here agricultural information is demanded. The ravages of the sugar cane borer (*Diatrœa saccharalis*) have been traced to practices of handling the cane during fall planting, windrowing, and spring planting, and to the planting of corn on land previously devoted to second-year stubble. Here, again, a change in a rotation system and common practices of handling the crop are involved in preventive suggestions. In fact, the best methods of control of many of the insect enemies of a diversified agriculture are to be found in the adjusting of agricultural practice to biologic conditions. Evidence of this may be found in the recommendations for the corn root aphis, the Hessian fly, the cotton boll worm, the tobacco worm, the differential grasshopper, the North American cattle tick, the corn root worm, wireworm and cutworm, and many other pests of general distribution.

The invasion into the Southern States of the Mexican cotton boll weevil, and its effect upon a crop of international importance, enlisted unusual interest in methods of control. Growing out of the efforts made in connection with the boll weevil, more than any other insect, has the relation of detailed biologic study to the cultural methods of remedial relief been emphasized, if not permanently established. Never before have the importance of a study of agricultural conditions and the habits of most plants been so intimately associated in the development of preventive methods. Our standing with the farming fraternity and our opportunities to promote entomological investigation in its broadest and most acceptable field seem to suggest an intimate study of conditions that will protect in the most economical way the

interests of the crop producer. If a change in the system of cropping is necessary, recommendations in keeping with the best practice should be available. If postponement of the time of seeding will bring relief from insect attack, the influence on yields from other causes due to late seeding should be carefully studied, and estimated, and compared with the losses occurring from the damage under normal conditions. Some may think these matters belong to other departments of agricultural investigation, and that the recommendations which are the outcome of biological study should be turned over to other persons for their execution. Such action is not in keeping with the crop producer's estimate of agricultural organization, and he is an important factor in the successful development of any remedial plan. Delay consequent on the shifting of the execution of any method or methods is destructive of the best interests of agriculture and of the various sciences which make up its multifarious structure.

In concluding, I wish to express confidence in the opportunities offered to economic entomologists for the development of preventive and remedial measures against insect attack, by the timely correlation of a thoroughly matured knowledge of agricultural conditions with an exhaustive life-history and habit study.

The discussion of this address was postponed until the afternoon session.

A paper was presented by Mr. Smith:

CULTIVATION AND SUSCEPTIBILITY TO INSECT ATTACK

By John B. Smith, *New Brunswick, N. J.*

(Abstract.)

It is a common complaint in New Jersey by fruit growers that care best for their orchards, that some of their neighbors that never spray suffer less from the pernicious scale than they; and there is a basis of fact for the complaint. In almost every section of the state there are old orchards, chiefly apple, that bear annual crops of good or fair fruit, practically free from scale, though no spraying work is ever done in the orchards and the trees have been infested for years.

Investigation brought out a few facts that seem to be suggestive. *First,* as a rule, vigorous, sappy growth is much more generally infested and injured than slow, hardy growth. *Second,* trees growing in well cultivated orchards, highly fertilized, are much more likely to suffer from scale attack than others. *Third,* trees that grow slowly, or in sod, without much care, are much the more resistant to scale

attack. *Fourth,* trees that become infested while young and growing vigorously, suffer much more than trees that do not become infested until they have reached bearing age. *Fifth,* trees that have been infested for some years, have been more or less persistently treated so as to keep down the insects, and have then been abandoned, not infrequently clean themselves and become and remain practically free from scale afterward.

Some suggestions derived from these facts are, that possibly trees are being stimulated to rapid growth at the expense of hardiness, and that the nitrogenous fertilizers used to produce quick and large trees actually lessen resistant power to insect attack. It would seem in place to inquire whether there should not be a modification of our practice that would induce a hardier growth and one more resistant to scale attack. Instead of adopting a practice calculated to secure size, try to secure one that would give greater hardiness even at the expense of mere growth. That there is a variation in susceptibility among varieties is universally known; it should not be impossible by selection and proper treatment to secure both quality and resistance. It is unscientific to devote ourselves merely to securing and testing spray mixtures, however necessary these may be for immediate results, if there is a possibility of securing exemption by increasing resistance or by adoption of fertilizing methods more in accord with the real needs of the plants.

A general discussion of the paper followed. Mr. Taylor suggested that the fruit grower might lose more by failure to cultivate his orchard in order to dwarf the trees than he would gain by making them more resistant to scale attack.

Mr. Smith stated that the paper should not be construed as an argument to do away with the cultivation of orchards. It is possible that fertilizers might be used to advantage to produce a short, hardy growth rather than a large amount of new wood. He thought it might be desirable to use lime in the orchard and to reduce the amount of nitrogenous fertilizers.

Mr. Felt stated that he had observed in certain parts of New York the same conditions to which Mr. Smith had referred in his paper. He recalled several orchards where the San José scale is doing little, if any, injury, which is probably due to the condition of the trees.

Mr. Rumsey asked if anyone had noted any difference in susceptibility to attack in Ben Davis apple trees. No data on this point was presented.

Mr. Burgess remarked that in his experience the orchards which

[redacted]

make a very short growth of wood annually and are thereby enabled to resist scale attack are usually neglected by the owners and do not yield profitable crops of fruit. The best growers aim to secure a large amount of new, vigorous wood, as this insures better quality of fruit. This practice is particularly true in peach culture.

Mr. J. L. Phillips stated that in Virginia fruit growers are attempting to keep their trees in a vigorous condition and are able to secure profitable crops by spraying to hold the scale in check. The trees which are not being injured by the scale and where no spraying is being done, are neglected ones that are not a source of profit to their owners.

Mr. J. G. Sanders called attention to the fact that healthy, vigorous trees increased the fecundity and growth of infesting scale insects to a remarkable degree; the reverse being true in old, enfeebled trees. He stated that by transferring the cottony maple scale (*Pulvinaria innumerabilis*) to various vigorous plants he had reared forms that had been previously described as distinct species of that genus. By transferring this species from thickly infested maple trees to vigorous young lindens and sycamores he had secured specimens three times the size of the original females and a corresponding increase in egg production resulted.

President Morgan remarked that the paper under discussion was one that should interest the nurserymen and horticulturists and called on Prof. Craig for remarks. The latter expressed the opinion that the entomologists should go very slow in advocating any method of preventing scale injury along the line of doing less spraying or of practising less cultivation in the orchard. Fruit growers are always on the alert for some easy method of destroying this pest and he feared that statements of this sort from officials would be used by careless and indifferent growers as an argument for doing nothing.

A paper was read by Mr. Washburn:

FURTHER OBSERVATIONS ON THE USE OF HYDROCYANIC ACID GAS AGAINST THE FLOUR MOTH

By F. L. Washburn, *St. Anthony Park, Minn.*

(Withdrawn for publication elsewhere.)

The Secretary briefly reviewed a paper received from Mr. A. L. Herrera, Mexico City, Mexico, on "Notes on the Orange Worm" (*Trypeta ludens*), and exhibited a colored plate which accompanied the paper.

Mr. W. D. Hunter gave a description of the able work that Mr.

Herrera is doing in Mexico and referred to some of the difficult problems which he encounters.

Mr. Felt presented a paper as follows:

OBSERVATIONS ON THE BIOLOGY AND FOOD HABITS OF THE CECIDOMYIIDAE

By E. P. Felt, *Albany, N. Y.*

The species belonging to this family, though small and easily distinguished from most other Diptera, are exceedingly abundant and subsist in the larval stage under quite varied conditions. The majority of forms live upon plants and a goodly proportion produce galls. These peculiar structures occur upon the roots, root stalks or underground buds, along the stem, on the branches, on the leaves or even among the flowers or flower heads as the case may be. One genus for example, *Rhopalomyia*, attacks all parts of various Solidagos, except perhaps the root, the galls being quite varied in character and the adults from the same representing distinct species and, so far as known to us, coming only from galls possessing certain characters. On the other hand, *Asphondylia monacha* O. S., a most striking form, occurs not only in terminal rosette galls on the narrow-leaved Solidago, *Euthamia lanceolata* and *E. graminifolia*, but may breed in apparently unaffected florets of the same plant or may be found in what we have designated as adherent galls on *Solidago canadensis* and *S. serotina*. These latter structures are inhabited by two species belonging to as many genera and appear to be produced by the female laying eggs between the closely apposed young leaves in the rapidly growing bud. The larvæ cause a depression on each surface and the margins adhere, so that when the plant develops and the leaves turn down, the pair affected adhere at the point of injury though their bases are an inch or more apart. The form of the gall appears to be determined largely by the location and number of eggs the female deposits; for example, the midrib deformity on ash leaves, known as the gall of *Cecidomyia pellex*, may range in length from about ½ to 2½ inches. It appears to develop directly as a result of the larval irritation on the upper surface of the midrib; the size of the gall being proportionate to the number of larvæ, small ones having perhaps five or six, while the largest may have as many as 50 to 60. Certain species breed in more or less regularly rolled leaves, and in this case there seems to be a comparatively slight irritation and the form of the roll is governed mostly by the location of the larvæ and the structure of the leaf. Other species subsist in more or less irregular depressions, and here again the irritation is comparatively slight. There is one form, for example, which produces a slightly depressed rectangular area on the

underside of milk-weed leaves. The boundaries of the deformity are evidently limited by the stout reticulating veins characteristic of this plant. The circular ocellate gall on hard maple, known as *Cecidomyia ocellaris*, is presumably produced in the same way, and its form is governed by ordinary mechanical laws, as there are few rigid veins to modify its margin. The form of irregular subcortical galls on various shrubs and certain herbaceous plants appears to be determined very largely by the degree of infestation, and this is presumably limited by the egg-laying habits of the female. There are, in addition to the gall-making species, a number of forms which may breed in decaying wood, in other rotting vegetable matter, or subsist upon fungus or even prey upon other species such as Aphids and Acarids.

The duration of the life cycle varies greatly between the different groups, and in some cases, apparently among members of the same group. It is presumable that most of the Lasiopterines and the somewhat nearly related Rhabdophagas and their allies produce but one generation annually. The same is probably true of most of the Asphondylines and presumably of numerous representatives among the higher groups, including such well known species as the pear midge, *Contarinia pyrivora,* and the introduced European *Contarinia rumicis,* which breeds in the seeds of *Rumex crispus.* On the other hand, certain species like the Hessian fly, *Mayetiola destructor* Say and the violet gall midge, known as *Contarinia violicola,* complete the life cycle within a relatively few weeks, and the number of generations is governed almost entirely by climatic conditions and the presence of a supply of suitable food. A large number of our species winter within their galls in the larval stage. This is true of all Lasiopterines known to us which occur in subcortical galls, in stem galls and in at least certain of the blister galls. It is also the case with certain Hormomyias producing leaf galls on hickory. Others forsake the gall and winter in subterranean cells, possibly under vegetable debris and frequently in well-developed cells.

There are some exceedingly interesting correlations existing between these forms and their food habits. Among the Lasiopterines, for example, the genus *Clinorhyncha,* represented in this country by at least one introduced European species (*C. millefolii* Wachtl.) appears to breed entirely among the florets of certain compositae such as yarrow, tansy and the common daisy. Another genus, provisionally referred to *Baldratia* Kieff., breeds in very large measure in the peculiar, apparently fungous affected blister galls so abundant on solidago and aster, though at least one form has been reared from an apparently unaffected leaf of *Erigeron.* Larvæ belonging to *Lasioptera* occur largely in subcortical galls on the stems or branches

of certain shrubs and herbaceous plants, there usually being a number of larvæ in each gall. The botanical genera, *Solidago* and *Aster*, appear to be prime favorites with this group of insects. The willows, *Salix* species, have a peculiar fauna, and it is worthy of note that, so far as known to us, not a Lasiopterine has been reared from an American *Salix*, though a species of *Clinorhyncha* was taken on this plant. This is the more remarkable, as they occur abundantly in subcortical galls on a number of shrubs and trees such as *Sambucus*, *Viburnum*, *Lindera*, etc. The genus *Salix* appears to be a prime favorite with Cecidomyiidæ referable to *Rhabdophaga* or nearly allied genera. These insects produce varied subcortical galls on stems and branches, and are also responsible for several bud galls. The poplar, *Populus* species, differs markedly from *Salix* in its Cecidomyiid fauna. A European species of *Lasioptera* has been reared from this genus, while in America we have obtained but one species of *Rhabdophaga*, as contrasted with some ten or more bred from *Salix*. We have bred, presumably from poplar, a representative of the aberrant genus *Oligarces*. There are, in addition, a number of leaf galls occurring on poplar, upon which we are not prepared to report. Many representatives of the genus *Dasyneura* and its allies subsist in loose bud galls or folded leaves such, for example, as *Dasyneura leguminicola* Lintn., which breeds in clover heads, the European *D. trifolii* F. Lw. in the folded leaves of clover, and *D. pseudacaciæ* Fitch in the folded leaves of black locust. The larvæ of *Dasyneura flavotibialis* Felt subsist in fungous affected, rotting wood. *Oligotrophus asplenifolia* Felt was reared from the folded leaves of sweet fern, *Comptonia asplenifolia*, while several species of *Rhopalomyia* occur in large numbers in compound terminal heads of *Solidago*. Certain species of *Hormomyia* breed in some of the well known hickory leaf galls, while the larva of *H. crataegifolia* lives in a leaf fold on *Crataegus*. Some European species of this genus have been reared from galls in grass stems, and undoubtedly certain of our American forms have similar habits. Many members of the Diplosid group occur in folded leaves, loose tip galls or even in more or less abnormal florets.

Some of the incident perplexities of this work are illustrated by our having reared four species of Diplosids from florets of the spreading Dogbane, *Apocynum androsaemifolium*. A rather irregular, loose leaf fold gall on the base of hazel leaves may produce three or four species, while we have obtained two distinct forms from the rather well known tumid leaf gall on grape, ascribed to *Lasioptera vitis* O. S. There is, in addition, a petiole gall on grape which has produced three forms referable to as many genera, while the common horseweed, *Erigeron*, normally produces two entirely different species.

It is impossible to state at the outset just what material may or may not produce Cecidomyiidæ, since we have bred a species of *Lasioptera* from an apparently normal Diervilla stem only ⅛ of an inch in diameter.

Afternoon Session, Friday, December 27, 1907.

The session was called to order at 1 p. m. and the presidential address was discussed.

Mr. J. B. Smith stated that he considered the address very timely. He believed, however, that owing to the recent extension of the field of the economic entomologist that there is danger that he may unconsciously get out of his proper field of work. In insecticide investigations the entomologist should secure the coöperation of the chemist. He is satisfied that the diseases of the brown-tail and gypsy moths had destroyed more of the insects than the parasites, but in this field the work of the plant pathologist is needed. Certain cranberry insects have modified the entire plan of cranberry culture, while in the mosquito campaign in New Jersey, where about 15,000 acres of salt marsh have been drained by the construction of over 2,200,000 feet of ditches, the problem has become one of engineering to a large extent. He believed that when we get outside the range of entomology, experts in the allied sciences should be consulted.

Several other members expressed their appreciation of the address.

Mr. Newell presented the following paper:

NOTES ON THE HABITS OF THE ARGENTINE OR "NEW ORLEANS" ANT, IRIDOMYRMEX HUMILIS MAYR.

By Wilmon Newell, *Baton Rouge, La.*

It is not often that the economic entomologist is privileged to behold the coming of a new and dangerous pest, to see its numbers rapidly increasing for several years before it attracts more than casual attention from the "layman," and yet be practically powerless to avert the threatened catastrophe.

An insect problem practically unheard of by the majority of the members of this Association, is now presenting itself in the State of Louisiana, and will shortly present itself to most if not all of the southern portion of this country. It is, withal, a problem which in the writer's humble opinion will rank in magnitude alongside the problems presented by the San José scale, gypsy moth and boll weevil, but in marked contrast to these it is not likely to admit of remedial measures being as easily applied.

In his brief experience as an entomologist, the writer has not encountered or heard of any species which exercises its destructive abilities in so many different directions. As a household pest I venture the opinion that this ant has no equal in the United States. It is both a direct and indirect enemy of horticulture; direct by actual destruction of buds, blooms and fruit, and indirect by its fostering care of various scale insects and plant lice. In the latter role it becomes also an enemy of importance to shade and ornamental trees and plants. By its association with *Pseudococcus calceolariae* (Mask) it may wipe out, or at least make unprofitable, the production of cane sugar in the South. By its successful antagonism of beneficial forms it becomes doubly injurious. The varieties of *Solenopsis geminata*, now regarded as extremely important in the natural control of the boll weevil, are likely to be greatly reduced in numbers by *Iridomyrmex humilis* and thus the latter species may become the indirect cause of damage to the cotton crop. Even as a menace to human life, under certain circumstances, this little ant cannot be entirely ignored. To this I shall refer later.

History and Introduction.

The species was first described as "*Hypoclinea humilis*" by G. Mayr, in 1868, from workers collected in 1866 near Buenos Ayres in Argentina, the original description appearing in the *Annuario della Soc. Naturalisti Modena*, Vol. III, page 164. Following is Mayr's description of the species, kindly furnished by Dr. W. M. Wheeler of the American Museum of Natural History, from the original edition:

"Operia: Long. 2.6 mm. Sordide ferruginea, micans, mandibularum parte apicali flavescenti, abdomine nigrofusco, tarsis et nonnunquam tibiis testaceis; miscroscopice adpresse pubescens; absque pilis abstantibus; subtilissime coriaceo-rugulosa, mandibulis nitidis sublaevigatis punctis nonnullis; clypeus margine antico late haud profunde emarginatus; thorax inter mesonotom et metanotum paulo et distincte constrictus, pronoto fornicato, mesonoto longitrorsum recto, transversim convexo, metanoto inermi longitrorsum fornicato, pronoto paulo altiori; petioli squama compressa rotundata."

No mention of this species in the literature on economic entomology seems to have appeared prior to the publication of a paper by E. S. G. Titus, of the Bureau of Entomology, in the proceedings of the Seventeenth Annual Meeting of this Association,[a] reciting his observations made upon a trip to New Orleans in July, 1904, at the request of Prof. H. A. Morgan, who prior to that time, had recognized the dangerous nature of the pest. Mr. Titus's paper is replete with inter-

[a]Bulletin No. 52, Bureau of Entomology, U. S. Dept. Agr., p. 78–84.

esting information and in fact he secured a surprising amount of data in the limited time at his disposal. Since 1904 the species has frequently been referred to in the Louisiana press, usually as "the ant."

As with most imported species, the original time and place at which a foothold was obtained by the Argentine ant in Louisiana, must be largely conjectured. However, we are able to conjecture with rather strong circumstantial evidence to guide us. Not only does the testimony of inhabitants indicate New Orleans to be the original starting point of this species in the South, but its enormous numbers and the extent to which it has exterminated other species of Formicina confirm the opinion that it has been in New Orleans longer than elsewhere.

For the earliest record of its occurrence in New Orleans, I am indebted to Mr. Ed. Foster of the editorial staff of the New Orleans Daily Picayune. Mr. Foster has for years been a close student of insect life, and especially of Hymenoptera, so that his testimony may be accepted with the same confidence as that of a professional entomologist. Mr. Foster first noted *humilis* in New Orleans in 1891 and in a personal letter to the writer he thus gives the record:

"I have known the species since 1891. At that time it was a rarity in Audubon Park, but was very common in the section immediately above Canal Street. Below Canal Street it was not at all plentiful. The boundary of the nuisance then was virtually from Magazine Street to the river. The coffee ships from Brazil, I understand, have always landed about where the wharves are now situated (on the river front, adjoining the area above-mentioned), but from what we know of the spread of insect nuisances, the first batch of immigrants must have come in years before I came across their descendants."

Mr. Titus, quoting Mr. Baker, former Superintendent of Audubon Park, states that in 1896 "they extended over but a small area, reaching approximately from Southport docks to Carrollton Avenue, and from the river back to Poplar Street," and that "in 1899 they were first noticed in Audubon Park." This area, from Southport to Carrollton Avenue, is located about five or six miles northwest of the area between Magazine Street and the river, noted by Foster to be well infested as early as 1891. Mr. Baker therefore had not been familiar with the original area of heavy infestation, but merely noted the species after it had invaded the part of the town where he resided. Mr. Titus's information regarding the species being first noted in Audubon Park in 1899 was of course secured from citizens, who failed to note the ant until it had reached prodigious numbers in the same place that Foster had found it a "rarity" in 1891. The dissemination to Audubon Park was undoubtedly from the heavily infested area between Magazine Street and the wharves already referred to.

For years coffee ships from Brazilian ports have unloaded their cargoes at these wharves, and from what we now know of the habits of this ant, a ship could hardly set sail from any port where it occurs without carrying many workers and doubtless many queens as well.

On the authority of Prof. W. M. Wheeler[b], *I. humilis* is apparently a native of the Americas only in Brazil and Argentina. That the species was brought to New Orleans in the coffee ships from Brazil, seems so highly probable as to admit of little doubt. Incidentally it may be remarked that few, if any, merchant vessels now clear from the port of New Orleans during the summer months without having an abundant supply of *humilis* on board.

It may not be out of place at this point to call attention to the common name of this insect. The local name of "crazy ant"[c] has been applied to this species by some of the inhabitants of New Orleans, but it is far from being a desirable name. The most universal name in use is that of "New Orleans ant" and this seems to have been adopted by common consent on account of the species being so abundant in New Orleans. In view of the probable future importance of this insect the common name adopted now will likely remain a fixture in popular entomological literature.

It is manifestly unjust to attach the name of the Crescent City to this pernicious pest, for on neither the city nor its inhabitants can the responsibility be saddled for the introduction of this little ant.

As the species was first described from Argentina and as that country doubtless embraces a large part of the area in which the species is native, I should like to propose the name "Argentine ant" as being far more appropriate and specific than any yet suggested. I should like to see the species so recognized in the official list of insect names adopted and revised from time to time by this Association.

The dissemination of the Argentine ant from New Orleans to towns along the principal railroad lines within 200 miles of the city has not been particularly rapid, but has been very complete. To the eastward of New Orleans the infestation extends into southern Mississippi and to the westward as far as Lake Charles, La., a distance of two hundred miles, or nearly to the Louisiana-Texas state line. Down the Mississippi River the infestation is heavy the entire distance to the Gulf of Mexico, a distance of ninety miles. Northward the infestation reaches again into the State of Mississippi and in a more northwesterly

[b] Entomological News, Jan., 1906, p. 24.

[c] Since the above was written, Prof. W. M. Wheeler has advised the writer that the term "crazy ant" is applied in Florida and the West Indies to another species, *Prenolepis longicornis*.

direction at least as far as Alexandria, La., a distance of one hundred and ninety miles from New Orleans. Fully five thousand square miles are now included in the infested territory. Artificial dissemination is by far the most important means of distribution. Mr. Titus in his paper reviewed very completely this phase of the subject. Suffice to say that individuals by thousands, and even complete colonies, travel from infested points in shipments of groceries, feed stuffs, manufactured articles, timbers, etc. The spread of the species from the railroad towns into the surrounding country and into the broad fields of the large plantations is comparatively slow and in only a small part of the area designated as infested is the ant universally distributed through both town and country.

Economic Importance.

It is as a household pest that this ant has thus far attracted the most attention. Under houses, in dooryards, beneath outhouses, in compost heaps, in hollow trees and between the walls of dwellings the nests or colonies occur in abundance. From these nests foragers go
BOVE
forth by day and by night, being deterred only when the temperature falls below about 50° F. Whenever a foraging worker discovers anything which will serve as food hundreds and thousands of workers will gather within the half hour. In the case of my own residence, a new building, every square inch of surface in each room is regularly "patrolled" by the individual "scouts." No trunk, closet, book case, nor corner is left unexplored, and this despite the fact that since last spring I have waged constant warfare against them by destroying dozens of colonies with bisulphide of carbon.

Among the substances which serve the species as food may be mentioned sugars and syrups of all kinds, fresh meat, blood, lard, cream, fruit juices, honey, cakes and dead insects. Very few repellants are successful in protecting food stuffs. Even the time-honored method of placing table legs in bowls of water is but partially effective, for with the first accumulation of a dust film on the water the workers cross it without difficulty. In fact the surface film of perfectly fresh water is almost strong enough to support workers, and on more than one occasion I have seen a worker alternately swimming and walking across the surface of the water. Grocers, restaurant keepers and wholesale houses lose heavily by the inroads of this pest. A jug of molasses or a barrel of sugar, for example, containing several thousand ants is not entirely acceptable to the customer. The species does not sting, but can bite severely when so inclined, and sometimes becomes an annoyance to human beings. I have known of several cases where

people have had to place their beds, during the summer months, upon panes of glass covered with vaseline in order to pass the night in peace. There have been rumored cases of infants being killed by these ants, but so extreme a case has not come within my observation. That such might easily occur is not at all improbable. A neighbor of mine was awakened one night the past summer by the cries of an infant, about two months of age, lying in its cradle near at hand. Thousands of these ants were crawling over the child's body and into mouth and nostrils. It was necessary to repeatedly submerge the infant in a tub of water before all the persistent workers could be disposed of. Had the child not received immediate attention the consequences would doubtless have been serious.

The Argentine ant is particularly fond of the honey-dew secreted by Aphids and various scale insects, and in all localities the increase of Coccidae and Aphididae following the increase of these ants has been almost beyond belief. Many thousands of ornamental trees and plants in New Orleans have already been destroyed by scale-insects. Many complaints are also received that the workers eat into the petals and calyces of flowers of various kinds, and indeed it has now become almost impossible to produce cut flowers with profit in the city of New Orleans.

During the past autumn I have noticed the workers of this species assiduously attending the ordinary cotton plant-lice, apparently colonizing them upon the younger foliage. The cotton-louse is a species which is usually brought fully under control by natural enemies after the middle of June, but should this ant succeed in facilitating their increase during the summer and autumn these Aphids may come prominently to the front as enemies of the cotton crop.

As a direct enemy to fruit the ant is also important. At Audubon Park the past spring the entire prospective orange crop was destroyed by them, the workers eating into the opening fruit buds. Many complaints of this injury to oranges were reported to us from the lower Mississippi River and coast regions. The fig crop in the vicinity of New Orleans was this year almost entirely destroyed by them. The following, quoted from the New Orleans Times-Democrat of July 7, 1907, is not overdrawn: "The time of the ripening of the figs has come and the housekeepers have to watch the rich harvest of figs falling to earth day after day in their green immaturity from the beautiful trees that are so ant-infested it is almost impossible to pick the few that do ripen. The trees themselves are making a noble fight, but they will be conquered in the end, because the hordes that attack them are illimitable and possess a high intelligence simply marvelous when with our feeble human efforts we try to over-reach them."

It is in its relationship to the cane growing industry that *I. humilis* promises to be of most importance. Wherever this ant has become exceedingly abundant in the cane fields a mealy-bug locally known as the "poo-a-pouche" increases with great rapidity. This latter insect has been identified by Mr. J. G. Sanders of the Bureau of Entomology as *Pseudococcus calceolariae* (Mask). Not only does the poo-a-pouche heavily infest the growing cane, finding lodgment between the leaf and the cane itself and drawing heavily upon the sap, but in the spring of the year it is apparently colonized upon cane underground by *Iridomyrmex humilis,* and there it proceeds to destroy the germinating buds of the "plant cane." By way of parenthesis I should perhaps explain that one of the methods of propagating sugar cane is to plant the previous year's canes in rows during the winter and the bud at each joint develops the following spring, sending up a rapidly growing shoot. By the destruction of these developing buds below the surface of the ground in spring, the prospective cane crop is as completely destroyed as would be a crop of corn were some insect to devour all of the seed planted.

Mr. J. B. Garrett, of the Louisiana Experiment Stations, who has recently been making a study of this poo-a-pouche, finds that its distribution is by no means co-extensive with that of the ant, and that it occurs only in a small part of the territory now occupied by the latter. The poo-a-pouche occurs in destructive numbers on the plantations from New Orleans to the mouth of the Mississippi River, a distance of ninety miles. The fact remains, however, that this is the territory in which the ant is most numerous and most firmly established.

Mr. Garrett also expresses doubt as to the ant actually colonizing the poo-a-pouche upon the cane, and suggests at the same time that the unusual increase of the poo-a-pouche may be due to protection from its natural enemies, afforded by the ants. It happens that the varieties of cane most susceptible to this injury are among the best ones at present grown in the South. Unless some unforeseen factor injects itself into this problem, the entire sugar industry of the South will be threatened by this poo-a-pouche and the attending Argentine ant, which seems to be responsible for its rapid increase.

An interesting food habit of this species has become apparent to truck growers. The workers are very fond of lettuce seed and while we are not as yet certain that the lettuce seed are harvested from the mature plants, it is well established that the workers industriously dig up and carry to their nests freshly planted seed from the gardener's beds. In the infested territory some expedient has to be resorted to to protect the lettuce seed until they germinate, by which time they are safe from the attacks of this ant. The workers are fond

of corn meal, and if this be strewed thickly on top of the rows containing the lettuce seed, the ants will undertake to carry it away. By the time the meal is all removed, the lettuce seed has usually germinated. This practice is the most common one among the truck-growers. I have succeeded in protecting the lettuce seed by using tobacco dust scattered liberally on the ground over the seed, but it is not an entirely efficient repellent, for a small percentage of the workers burrow through it, seemingly without inconvenience or annoyance.

In what other fields this ant of cosmopolitan habits will become a disturbing factor remains to be seen.

Description.

In all the colonies which we have had under observation for several months, not more than three forms have been found, the females or queens, workers and males. Major and minor workers do not seem to occur nor do any individuals more than others act as soldiers or scouts. The original description of the worker by Mayr has been quoted above. As far as the writer can learn, the queen and male as well as the immature forms, have not heretofore been described.

At my request Prof. W. M. Wheeler has prepared a re-description of the worker, and descriptions of the queen and male, thus making a complete and comprehensive description of the species, which I give herewith:

Iridomyrmex humilis Mayr.

"*Hypoclinea humilis* Mayr. Annu. Soc. Natural Modena, 1868, 3: 144, No. 4, worker.

"*Hypoclinea (Iridomyrmex) humilis* Mayr, Verh. Zool. botan. Ges. Wien, 1870, 20: 954, 958, worker.

"*Iridomyrmex humilis* Emery, Zeitschr. f. wiss. zool. 46, 1888, p. 386. Taf. 28, Figs. 17–19 (gizzard).

Worker: Length 2.2–2.6 mm.

"Head oval, broader behind than in front, with its posterior margin slightly concave in the middle. Eyes flattened, in front of the middle of the head. Mandibles with two larger apical and several minute basal teeth. Clypeus short, convex in the middle, with broadly excised anterior margin. Frontal area and groove present but rather indistinct. Antennal scapes extending about one fourth their length beyond the posterior corners of the head. Joints 1–5 and the terminal joint of the funiculus distinctly longer than broad; remaining joints nearly as broad as long. Thorax slender, narrower than the head; broadest through the pronotum which is convex, rounded and nearly as long as broad. Mesonotum nearly as long as the pronotum, sloping, laterally compressed, in profile evenly continuing the contour of the pronotum. Mesoëpinotal constriction rather deep, extending obliquely downward and backward on each side. Epinotum short, nearly twice as high as long, convex on the sides, with a short convex base, and a longer, flatter and more sloping declivity. Petiole small, less than half as broad as the epino-

tum; its scale in profile, compressed, cuneate, inclined forward, with flattened anterior and posterior surfaces and rather acute apex; seen from behind its border is entire and evenly rounded or even slightly produced upward in the middle. Gaster small. Legs rather slender.

"Body minutely shagreened or coriaceous, subopaque and glossy; mandibles, clypeus and anterior border of the head more shining. Mandibles minutely and rather obscurely punctate.

"Hairs few, suberect, yellowish, confined to the mandibles, clypeus, tip and lower surface of the gaster. Pubescence short and uniform, grayish, so that the body has a slightly pruinose appearance.

"Brown; Thorax, scapes and legs somewhat paler; mandibles yellowish; apices of the individual funicular joints blackish.

Female (deälated): Length 4.5–5 mm.

"Head without the mandibles, but little longer than broad, with rather angular posterior corners, straight, subparallel sides and straight posterior border. Eyes large and rather convex. Mandibles and clypeus like that of the worker, scapes proportionally shorter and stouter. Thorax large, as broad as the head, elongate elliptical, nearly three times as long as broad. In profile the scutellum is very convex, projecting above the meso- and epinotum. Epinotum with very short base and long abrupt declivity. Petiolar node erect, more than half as broad as the epinotum. Gaster elliptical, somewhat shorter and a little broader than the thorax. Legs slender.

"Sculpture like that of the worker but more opaque; mandibles and clypeus also less shining.

"Scattered hairs more numerous than in the worker and also present in small numbers on the vertex, gula, mesonotum, prosternum and fore coxae. There is also a row of short hairs along the posterior margin of each gastric segment. Pubescence distinctly longer, more silky, and denser than in the worker.

"Dark brown; antennae, legs and posterior margins of the gastric segments reddish; mandibles, sutures of thorax and articulations of legs yellow.

Male: Length 2.8–3 mm.

"Head much flattened; including the flattened eyes, as broad as long. Vertex and ocelli prominent. Cheeks short. Mandibles small, overlapping, with a single, acuminate apical tooth. Anterior clypeal border straight. Antennae slender; scape only between three and four times as long as broad; first funicular joint globose, broader than any of the other joints; second joint much longer than the scape; joints 3–5 growing successively shorter; joints 6–12 considerably shorter and more slender. Thorax very robust, elliptical, broader than the head, which is over-arched by the protruding, rounded mesonotum. Scutellum even more prominent than in the female. Epinotum with subequal base and declivity, the former slightly convex, the latter feebly concave, forming an angle with each other. Petiole small, its node with rather blunt margin, slightly inclined forward. Gaster very small, elongate elliptical, with small rounded external genital valves. Legs slender. Wings with a four-sided discal cell and two well developed cubital cells. The costal margin is depressed or folded in just proximally to the stigma.

"Sculpture, pilosity and pubescence as in the worker; coolr more like that of the female, except that the antennae, legs, mandibles and internal genitalia are pale, sordid yellow. Wings smoky hyaline, with brown veins and stigma.

"*I. humilis* belongs to a small group of neotropical species embracing also *I. iniquus* Mayr, *dispertitus* Forel, *keiteli* Forel and *melleus* Wheeler. The workers of *keiteli* and *melleus* may be at once distinguished by their color, the former having a yellowish brown head and thorax and the remaining parts brownish yellow; the latter being pale yellow with a blackish gaster and funiculus. In these and in *I. iniquus* and *dispertitus* the mesoëpinotal constriction is much deeper than in *humilis* and the meso- and epinotum are of a different shape. The mesonotum in profile does not form a continuous, even line with the pronotum and the epinotum is very protuberant and almost conical. *I. humilis* represents a transition from the above group of species to that of *I. analis* Ern. André, which is very common in the Southern States. This species has a shorter, more robust thorax, more like that of *Tapinoma*, and much less constricted in the mesoëpinotal region.

"The above description was drawn from a number of workers, males and females taken from the same nest in Baton Rouge, La., by Mr. Wilmon Newell. The types described by Mayr were captured by Prof. P. de Strobel in the environs of Buenos Ayres."

An interesting point concerning the males, is that in certain colonies they occur in great abundance. This was first discovered by one of my assistants, Mr. G. A. Runner, who in December of 1907 found a colony in which the winged males were almost as abundant as the workers. Many other colonies which have been under constant observation for the past five months have not contained males at any time during that period. Prof. Wheeler has suggested that doubtless the appearance of a great many males in certain colonies is accounted for by the presence of egg-laying workers therein.

The Egg.—The egg deposited by the queen is elliptical, pearly white and without markings. As the time approaches for it to hatch it becomes duller in appearance but does not perceptibly change color.

The average size of the egg is .3 mm. long by .2 mm. wide.

The largest egg encountered while measuring a series was .34 mm. long by .24 mm. wide, and the smallest .27 mm. by .187 mm.

The rate of egg deposition has not been determined, but one queen under observation in a cage deposited at the rate of 30 eggs per day, now and then suspending oviposition for several days at a time.

The incubation period of the eggs in a glass cage in the laboratory extended from Oct. 1st to Nov. 15th, a period of 45 days, during which time the maximum temperature was 87° and the minimum 29°, with an average daily mean of 63°. Calculating the effective temperature from 43° F. and the actual mean for each day we find that 941 degrees of effective temperature were required for the develop-

ment of these eggs. This figure seems unreasonably high and I think it accounted for by the fact that I failed to provide the nest with sufficient moisture to make the conditions for incubation entirely favorable.

The Larva.—The larva when first hatched is hardly larger than the egg, and for some time after hatching remains curved, with the head and anal end practically together, so that the very young larva and eggs cannot be distinguished from each other without the aid of a good glass.

The larva is pure white, but with a dark color sometimes appearing in the abdominal region, as if it had been fed with some black or dark-colored food. When fully grown the larvae average 1.7 mm. long by .66 mm. wide.

Larvæ which were hatched from the eggs on Nov. 15, 1907, and which have been kept in a nest in my office, at ordinary living room temperature, now (Jan. 2, 1908) look to be fully grown and ready to pupate.

The Pupa.—The pupa in its earlier stage is pure white, without markings, except the compound eyes, which are jet-black and very prominent. As time for transformation approaches the pupa assumes a light brownish color, which gradually becomes a medium brown. So far as I can see there is no cocoon, or anything resembling it, surrounding the pupa, although the pupal skin, very thin and very fragile, is shed when the transformation to imago takes place. These pupal skins are carried out of the nest by the attendant workers. The color of the pupa in its final stage and that of the worker just transformed are practically identical, the latter requiring from two to five days after transformation to attain the deep brown color of the fully matured worker.

I have not secured any direct data upon the duration of the pupal stage, but from general observations my impression is that about three weeks' time, at an average temperature of 72° F. are required.

Habits.—Reference has already been made to the feeding habits of this ant, as well as to its relations with certain Coccidæ and Aphididæ. The colonies or nests are established in a great variety of places. We have found them in swampy ground where the earth was so wet that water would drip from it when squeezed in the hand. On the other hand I have found their nests between the walls of dwellings, where no moisture could reach them except such as was contained in the air. Nests have been found within hollow trees, beneath the rough bark of growing trees, in forks of trees, in rubbish and compost heaps, in decaying timbers, beneath boxes and boards, inside of brick foundations where accidental crevices occurred, in stored household goods,

and one colony was found domiciled between the tin wall and veneer covering of an abandoned kerosene can. In short, any locality that offers protection from the elements becomes a satisfactory home for this little creature. The species shows a marked tendency to construct nests in close proximity to any abundant food supply. If honey or molasses be placed in the same spot upon the ground for several days in succession, a small colony invariably burrows into the earth beside it. As to how new colonies are established, I am still very much in doubt. I have examined a considerable number of small nests which I knew to be but recently occupied, finding in them workers, eggs and larvæ but no queen. On the other hand I have found queens with foraging workers; one such was found with several hundred workers in a sack of sugar which was thoughtlessly left exposed for a few hours, and in rare instances a queen is seen crawling about unattended by any workers at all.

One of my assistants, Mr. G. D. Smith, has suggested that the communistic habit is carried by this species even beyond the colony itself and that colonies adjacent to each other form "communities," the inhabitants of which recognize each other as friends. There is indeed evidence to support this view. For example three colonies located in a line, about fifteen feet apart, were found to be in touch with each other, workers constantly traveling from one to the other.

The number of queens present in a colony may vary from one to many. I took as many as thirty-two queens from one colony and there were several more in sight when my supply of empty pill boxes became exhausted. It may be that the multiplicity of queens, and the age to which the workers attain, rather than the rate of oviposition, may account for the great abundance of individuals. The same theory might also explain why so many years have been required to bring the species into prominence after its introduction, as well as explaining its present strength. The increase of this pest strikes one as being steady and powerful, rather than sudden.

Though valiant fighters when other ants are encountered, the Argentine ant cannot be classed as a predaceous insect. I have yet to find them attacking any living insect or animal, the one exception being a cockroach which had been mashed, but which still possessed enough life to now and then move a leg or antenna. After insects are killed the ants feed greedily upon the body juices. They and my honey bees feed peacefully from the same dish of honey, and I have seen the ants clean off a bee which had been daubed with honey, without apparent annoyance to the latter.

Relation to Other Ants.—Prof. M. W. Wheeler, in Entomological News for January, 1906, gives an interesting account of how this

species obtained a foothold in Madeira and supplanted another introduced species, *Pheidole megacephala* Fabr.

In New Orleans where *I. humilis* is thoroughly established everywhere, it is rare indeed to find any other species. Titus in recounting his observations in 1904 said, "they have driven or killed out all other ants in the regions infested by them." The extermination of other species in the city of New Orleans has not been complete, but very nearly so. At Baton Rouge and other points which are now becoming quite heavily infested, the displacement of the native ants is easily observed. As examples I may cite two or three cases which have come under my observation. One day in August I noticed a small colony of *I. humilis* constructing a nest but a few inches distant from a colony of their near relatives, *Iridomyrmex analis.*[d] It was not long until the foraging workers from the *humilis* colony discovered their neighbors and whenever workers from the two colonies met a fierce battle ensued, usually ending in the *analis* worker being severely bitten and left to die. Five hours after these preliminary "skirmishes" were noticed I returned to the nest, to find *humilis* fully in possession and none of the former occupants of the nest anywhere in sight. The nest was dug up, but no trace of *analis* was found in it.

In September I witnessed an interesting attack by the *humilis* workers upon a fairly strong colony of *Solenopsis geminata.* The latter species is famed for its vindictiveness and for the effectiveness with which it uses its sting. In this case the victory was by no means an easy one for the Argentine ants, for the small (minor) workers of *geminata* were, one with another, as good fighters as the former. Both species made the petiole of the abdomen the objective point of attack, gripping it firmly between the jaws. About as many of the *humilis* workers were killed in these encounters as of the other species.

In attacking the larger (major) workers of *geminata* the *humilis* workers adopted somewhat different tactics. The *geminata* majors were several times larger than their antagonists and while far less active, quickly destroyed any *humilis* so unfortunate as to get between their mandibles. The Argentine ants therefore attacked them by rushing up and biting a leg or antenna and immediately retreating, sometimes as many as ten of the Argentines being thus engaged in the attack upon one of these major workers. Eventually the battle was won by *I. humilis,* purely by having innumerable reinforcements, and in about twenty hours had possession of the fortress they had stormed so long and faithfully.

The next morning in looking over the battleground I found many of the *geminata* major workers still alive but divested of all their legs.

[d]Determined by Dr. W. E. Hinds.

More interesting still was an attack made by Argentine workers upon the giant *Camponotus herculeanus* L., subspecies *pennsylvanicus* De G.* While watching a heavy stream of *I. humilis* workers passing up and down the bark of a large water oak tree one afternoon, three or four workers of the former species made their appearance, seeking food here and there on the same tree. Presently one of these giants crossed the line of *humilis* workers and was immediately attacked, the small ants fastening themselves to tibiæ, tarsi and antennæ and hanging on with bull-dog tenacity. With marvelous rapidity the large worker caught from one to three of her small adversaries at a time, crushed them between her jaws and threw them aside. She would reach from side to side and twist about to crush the little enemies clinging to her tarsi, but as fast as she could dispose of them others took their places. The extreme hatred which the little workers displayed towards this giant that had crossed their path was indicated by an Argentine worker which crossed the bark a couple of inches back of the *herculeanus* worker. Immediately the small worker changed its course and ran at full speed after the large one, catching up after traveling four or five inches, and at once attached itself to a hind tarsus. After watching this interesting battle for a considerable time the large worker was captured and placed in a cyanide bottle.

There are many other points to be mentioned in connection with this introduced pest, such as its probable future distribution, its natural enemies, measures of control, and the manner in which it is likely to affect various agricultural and commercial interests, were space to permit. The problem presented by this species is a large and complicated one and much tedious work of investigation will have to be done before the economic entomologist can claim a victory over this small but formidable foe.

This paper was listened to with much interest by the members present. Mr. H. E. Weed stated that workers of this species will carry food to their nests for a distance of three quarters of a mile. He said that people who did not live in the infested district utterly failed to appreciate the havoc that these insects were causing.

Three closely related papers were next presented, as follows:

LIFE HISTORY, HABITS AND METHODS OF STUDY OF OF THE IXODOIDEA

By W. A. Hooker, *Bureau of Entomology, U. S. Department of Agriculture.*

The intention in presenting this paper upon the life history and

*Determined by Prof. W. M. Wheeler.

habits of the ticks is to give a brief resumé of our present knowledge of the group. The species found in this country, according to Banks' latest list, number no less than thirty-four, and aside from the North American Fever Tick *Margaropus* (*Boophilus*) *annulatus*, but comparatively little is recorded relating to their biology. In looking through the records for information as to the habits of exotic species, we find but little beside the valuable work of Prof. C. P. Lounsbury, the Entomologist of Cape Colony. Realizing their importance, particularly in relation to the dairy industry, he began an investigation of them in 1898. His studies present two results: first, the remarkable discoveries that several dreaded diseases of domestic animals in South Africa are transmitted through the agency of ticks; and second, the elucidation of the life history and habits of a number of species, including that of *Amblyomma hebraeum, Haemaphysalis leachi, Rhipicephalus appendiculatus, Argas persicus,* and more or less completely that of others. Wheler, in England, has given valuable information on the biology of the old world Linnaean species *Ixodes ricinus,* also found in this country, as has Prof. H. A. Morgan upon several species and Dr. H. T. Ricketts on *Dermacentor occidentalis.*

In connection with the study of the biology of the North American fever tick, the writer (under the direction of Mr. W. D. Hunter) has taken up the study of other species also, because of their importance as external parasites and because of their possible agency in disease transmission. In this work frequent reference has been made to the publications of the before-mentioned investigators. In addition the writer received valuable information and suggestions from Professor Lounsbury during his visit to this country the past summer. As a result nearly the complete life cycles of eight species represented in this country have been followed in addition to that of the North American Fever Tick *Margaropus* (*Boophilus*) *annulatus,* so that granting the life history and habits of the European Castor-bean Tick *Ixodes ricinus,* to be the same in this country as found by Wheler, in England, we are now acquainted with that of ten native species, and have data on two additional species.

The ticks are of primary importance in their transmission of disease. At least ten distinct diseases of man and the domestic animals are known to be thus transmitted, no less than sixteen species of ticks being implicated. Again they are of great importance as external parasites because they irritate and drain the system of the animal attacked and are followed in some hosts by the screw-worm fly (*Chrysomyia macellaria*), which deposits her eggs at these points of entrance, with resultant injury.

It is well known that in order to develop, it is necessary for the ticks to attach to and suck blood from some animal and that unless such host is found within a certain period, which varies mainly with the temperature and precipitation, that it will starve. Upon this knowledge as related to *Margaropus* (*Boophilus*) *annulatus* is based the method of freeing pastures by the so-called rotation system as first worked out by Prof. H. A. Morgan.

All ticks pass through four distinct life stages: the egg, the larva or seed-tick, the nymph or yearling-tick, and the adult or sexually mature stage. The female, following the engorgement of blood, becomes greatly distended and drops to the ground, crawls to some protective covering, and soon commences the deposition of large numbers of eggs. In the course of a few weeks these hatch into the six-legged larvæ or seed-ticks, which await the coming of, or in some species crawl to, the host. Having found a host they attach and soon engorge with blood, after which they either molt while attached or drop and pass a short period of quiescence during the metamorphosis, then appear in the eight-legged nymph stage.

A second engorgement takes place and the ticks either molt attached or drop as before, pass a period of quiescence, then molt and appear in the adult stage. Another, the third engorgement, is followed by dropping and oviposition, and the generation is completed. In the Spinose Ear Tick, *Ornithodoros megnini*, we find a variation from this. It drops as a nymph and, following the molt, without engorging as an adult, commences oviposition. In the genus *Argas* a second nymphal engorgement and molt takes place. In the family *Ixodidæ* death follows the completion of oviposition, but in the genus *Argas* of the family *Argasidae* repeated engorgement takes place, followed each time in the female by the deposition of eggs.

The appearance of the active stages of the ticks varies greatly from the unengorged to the gorged, excepting in the male, which does not engorge with blood, but seems to exist upon serum. Because of this variation in appearance, individuals of the same species have been described as different species. The nymphal stage can be separated from the adult by the absence of the genital pore. The sexes can only be distinguished after the final molt, except in a few species in which the high color markings can be seen through the nymphal skin a day or two prior to molting. As adults they are separated readily in the *Ixodidae* by the shield or scutum, which in the female covers but a small part of the dorsum, but in the male completely covers it. In the *Argasidae* the sex can only be distinguished by the shape of the genital pore, which in the male is crescent shaped, while in the female it is merely a transverse slit.

The position of the genital pore varies from midway between the front coxæ to midway between the posterior pair.

The ticks are naturally separated into three classes according to their habits of molting as suggested by Ransom: first, those which pass both molts upon the host, represented by members of the genus *Margaropus* and by *Dermacentor nitens;* second, those in which the first molt is passed upon but the second off the host, represented by *Ornithodoros megnini* of this country and *Rhipicephalus bursa* and *evertsi,* two South African species; third, those in which both molts are passed off the host, as is the case with most of the ticks found in this country.

A fourth class might be recognized to include those which drop to pass the first molt, but which remain upon the host for the second; as yet, however, no representative of this class has been found.

Of importance in connection with the transmission of disease is the fact that while the first class pass the entire parasitic period of a generation upon a single host, yet the second may attach to two and the third class to three separate hosts.

It will be seen that in the first class, where the ticks molt upon the host and instead of having to wait long periods to find a host, they merely continue sucking blood from the same animal. As a result these ticks reproduce very much the faster and become of greater importance as external parasites, where numbers and the removal of blood are considered. This is the case with our fever tick. In the class where both molts are passed off the host and a host found three separate times for each generation their chances of reaching maturity are lessened as compared with the first class by the proportion of three to one. They have overcome this great disadvantage it would seem by having become more resistant to heat and cold and by having gained the power to withstand much longer periods of fasting, as well as by having acquired adaptation of habits. This will be discussed under the heading of host relationship.

While the representatives of the first class, all belonging to the sub-family *Rhipicephalinae,* are more numerous, yet their greater importance as external parasites is to some extent surpassed by the third class, particularly by the members of the sub-family *Ixodinae,* owing to the fact that the much greater lengths of the hypostome permit of several times deeper penetration. As the result of this deep penetration by the *Ixodinæ,* an inflammation is produced ofttimes resulting in suppuration. Frequently in the attempt to remove ticks belonging to this latter class from the body of the host, the capitulum is separated from the body of the tick and remains embedded in the host. Lounsbury reports that in some sections of South Africa dairy

farming is becoming well nigh impossible in consequence of this deep penetration by *Amblyomma hebraeum*. Their attachment is followed by suppuration and sloughing of the teats; dairy herds in that country are often found in which one at least of the teats of each cow of nearly the entire herd is missing or injured so as to be useless.

With many species it is the habit shortly after hatching or molting to crawl upon nearby herbage, as grass, weeds and shrubs, or temporary structures, as fences and posts, and there await the approach of the host. When closely observed, the front pair of legs will be seen waving in the air, ready to attach to the host as it comes in contact, while with the other legs it holds to its support. In other species, as is the case with *Amblyomma hebraeum*, recorded by Lounsbury, the ticks are not satisfied with waiting, but start in search whenever a host comes near. In some species the waiting seems to be upon the ground.

Host Relationship.—Most species of ticks have certain hosts or group of hosts upon which they are largely dependent for existence. From this fact have arisen many of our common tick names, as the cattle tick, the dog tick, the fowl tick, the rabbit tick and many others. Many of these, however, more or less frequently attach to other hosts. The former may be termed the usual host or hosts and the latter the accidental or temporary host or hosts. There seems to be a rather close analogy between ticks and fleas as regards hosts. In his revision of the Siphonaptera, p. 268, Baker mentions rabbit fleas as remaining on a human being for some little time, biting frequently while there, still not frequenting that host nor its clothing or bed. He considers it very probable that many of the records of fleas refer merely to the temporary host, since the cases of temporary hosts are quite common. To illustrate how fleas would find these temporary hosts he mentions the possibility of the rabbit running into a badger hole, or the mouse into a mole burrow; that an owl's eating a mouse or a cat's devouring a rat would be favorable conditions for this temporary transference. Similar instances will account for many of our accidental hosts of ticks. Experiments conducted during the past summer by the writer have shown that when confined in a bag in close proximity to the scrotum of a bovine, nearly all of the Ixodids will attach. As a result of these accidental or temporary attachments for some species we have large host lists, including hosts upon which the ticks could only occasionally or never reach maturity. Lounsbury has found a peculiar habit in *Hyalomma aegyptium*; as a larva it will not feed on any mammalia, but attaches to fowls upon which the first molt is passed. Following the second molt, which takes place off the host,

with the exception of the dog, it attaches to almost all domesticated mammalia.

Mammals serve as the principal hosts of the ticks. Fowls are largely the hosts of the genera *Argas* and *Ceratixodes,* and of one or two species of the genus *Haemaphysalis.* Several species of the genera *Ixodes, Amblyomma* and *Hyalomma* are also parasitic upon fowls. The reptiles are not immune, several species attaching to them.

Adaptations as factors in Host Relationship.—It cannot be doubted that a great evolutionary process has taken place in the adaptation both of structure and of habits as related to reattachment and protection. It is not the intention of the writer at this time to enter deeply into a discussion of this matter but merely to mention the result of this great natural process as he sees it. This evolutionary process or survival of the fittest has resulted in the special adaptation, first of function and structure, and second of the habits of ticks.

All ticks must find hosts and attach at least once, some as many as four times. This necessity has resulted in *Special adaptation of function and structure for attachment.* An illustration of this adaptation of function is found in the way the Ixodids use the front pair of legs. As one approaches the free tick these legs can be seen waving in the air, while with the others it holds to its support. When a host comes in contact with them they cling to it most tenaciously with these legs. To determine the fact one has but to pass a finger rapidly over a cluster of the seed-ticks. The *adaptation of structure for protection* is represented by the engorged larvæ of *Argas miniatus* or *persicus.* Up to within a few hours of dropping these larvæ are globular in shape, but at this time they flatten and assume the typical Argas shape; this flattened form, natural to all of the other stages, permits the ticks to crawl rapidly and to secrete themselves in cracks and crevices protected from the wily fowl. In the *Ixodinæ* we find what may be considered specially adapted mouth parts, which being unusually long, penetrate deeply and prevent their being easily removed.

In the *adaptation of habits favorable to attachment and protection* we find most striking illustrations of the great process of natural selection. The adaptation of habits favorable to attachment may be placed in four classes: first, in molting; second, in attachment to any host; third, of habits to habits of host; and fourth, in acquired greater vitality. There is a great disadvantage in dropping to molt, for it necessitates long periods of waiting, and results in a high percentage of mortality from not finding the host. This disadvantage seems to have been overcome by some species which have acquired the habit of

molting on the host, for example, by the various species of *Margaropus* and by *Dermacentor nitens*. To this class belong several other species which have partially overcome this disadvantage in their passing the first molt upon the host. Two representatives of this class are the South African species, *Rhipicephalus bursa* and *evertsi*. A species of *Haemaphysalis*, which has recently been discovered by the writer to occur frequently upon the heads of birds in the southern part of the United States, also seems to have acquired this habit, at least partially, for it has been determined by the molted larval skins that the first molt is so passed. It has been overcome entirely by *Ornithodoros megnini*, the Spinose Ear Tick, in a somewhat different way, that is, by passing the first molt upon the host, then feeding sufficiently as a nymph, so that following the second molt, which takes place off the host, engorgement as an adult is unnecessary for oviposition and probably never occurs.

Even in species most diverse in their tastes there are some hosts especially favored; this in some cases may be accounted for by the great numbers of that host.

In the class which has adapted its habits to the habits of the host, the ticks are confined largely to a host or group of hosts with similar habits. In the studies of the ticks made by the writer, these adapted habits have been found most interesting. The species *Haemaphysalis leporis palustris*, commonly known as the Rabbit Tick, has adapted itself to the habits of the Leporidæ, the hares and rabbits, and only accidentally attaches to other hosts. It is the habit of the hares and rabbits to remain more or less inactive during the day in their "forms" or resting places, protected by a clump of grass or bushes from enemies such as birds of prey, their activity being largely at night The writer has found that this tick following engorgement drops largely during the day, in other words when the hares and rabbits are in their forms or resting places, to which places they or others return to pass the day. Thus, when the ticks have hatched or molted and are ready to attach, they have little trouble in finding the host. This same habit has been acquired by the Fowl Tick, *Argas miniatus*, which in the engorged larval stage, the writer finds drops only at night (except accidentally) when its host, the fowl, is upon the roost. Thus when ready to re-attach it is near and readily finds the host, whereas had it dropped during the day when the fowl was on the "run" the chances of its finding a host would be greatly lessened. A habit apparently acquired by *Ornithodoros megnini* is that of crawling to a height of several feet from the ground as a nymph before molting and depositing its eggs; thus when the seed-ticks appear ready to attach they will be rubbed off by the horse, cow or other host and readily find

ADAPTATIONS AS FACTORS IN HOST RELATIONSHIP.

- Adaptation in the ticks.
  - Adaptation of function and structure.
    - for attachment
      - represented by the adaptation of the front pair of legs of the Ixodidae, to attachment.
    - for protection
      - represented by shape of engorged larval nymphs and adults of *Argas miniatus* and by the increased length of mouth parts of the Ixodinae.
  - Adaptation of habits.
    - for attachment
      - 1-molting on host.
        - *Margaropus* sps., *Dermacentor nitens*, etc.
      - 2-attachment to any host.
        - Many species.
      - 3-adaptation of habit to habit of host.
        - *Argas miniatus*, *Haemaphysalis leporis palustris*, *Ornithodoros megnini*.
      - 4-acquired greater vitality.
        - Many species.
    - for protection
      - 1-accelerated engorgement.
        - *Argas miniatus* and *persicus* *Margaropus*, *annulatus*, etc.
      - 2-position of attachment to body.
        - *Ornithodoros megnini*, *Dermacentor nitens*, *Haemaphysalis* sp. on birds.
      - 3-nocturnal habits.
        - *Argas* sps.

access to the ear. These species furnish what evidence we now have of the adaptation of habits to the habits of the host, but I have no doubt that similar habits will be discovered in other species when they have been given sufficient study.

It seems probable that in the species which drop to pass their molts greater resistance to high and low temperatures and the power to withstand long periods of fasting have been acquired. Again the species which have acquired the habit of molting on the host has probably lost in this power of resistance.

As related to protection, the *adaptation of habits* may be considered under accelerated engorgement, attachment to favorable part of body, and nocturnal habits. Of *accelerated engorgement* we have several instances among the ticks. This is best illustrated by *Argas persicus* and *miniatus* in their engorging within a few hours at the most. Lounsbury argues that they are descendants from forms which remained for days at a time on the host. That this is the case is shown by the larva, which still remains upon the host for days to engorge. In the Cattle Tick, *Margaropus annulatus*, after it has become about one third engorged, which requires a number of days, complete engorgement takes place and the ticks drop within a comparatively few hours. In this way the chances of destruction due to the removal by enemies such as birds and the attack by parasites have been reduced to the minimum.

Again we find species which have adapted their habits for protection in attaching to favorable parts of the body as have *Ornithodoros megnini* and *Dermacentor nitens* in attaching to the inside of the ears. The species of *Haemaphysalis* found upon quail, field larks (and other ground-feeding birds) in Texas, Lousiana and Florida, appear to attach only to the head, a place from which they are not easily removed by the fowl. Perhaps the most highly developed habit acquired by ticks for protection is that found in the nocturnal habits of the genus *Argas*. Through this habit of resting during the day time, they escape detection by the fowls, which, upon discovery, devour them with great avidity. At night the fowls come to their roost near by and the ticks have little trouble in finding the host and engorging at a time when the fowl is inactive, and thus largely escape detection and destruction.

Mating.—In the *Argasidæ* mating takes place after the final engorgement has occurred and the tick has left the host, but few observations having been recorded. In *Ornithodoros megnini* the nymph leaves the host, molts, and without further feeding is fertilized and commences oviposition.

In the *Ixodidæ* the mating appears normally to take place upon the

host, but some species have been observed in copulation off the host. In most of the species which pass their molts off the host (the genus *Ixodes* possibly excepted) it seems to be necessary that the male at least attach and take food before the sexual instinct is developed. In *Margaropus annulatus,* which molts upon the host, the male detaches as soon as the nymphal skin is shed and goes in search of the female, which it embraces when found and with which it remains in copulation until the replete female drops. The Brown Dog Tick, a species of *Rhipicephalus,* has similar habits, females often being found each with several males attempting to embrace them. Apparently *Dermacentor nitens* also has the same habit of remaining in copulation on the host. While the two sexes are usually nearly equal in numbers, yet by the dropping of the female and remaining of the male on the host, the latter are usually found present on the host in greater numbers. Lounsbury has made extensive observations upon the mating of *Amblyomma hebraeum,* the habits of which species are very remarkable. He has found that the female goes in search of the male, the latter accepting the female only after having attached and fed for several days. Considerable difficulty has been experienced by the writer in getting the sexes of the three species of *Amblyomma* and *Dermacentor variabilis* to copulate, and there remains much to be learned in relation to this habit. Mr. J. D. Mitchell has observed *Amblyomma americanum* apparently in copulation on shrubbery. Wheler mentions observing *Ixodes ricinus* as apparently in copulation off the host; this act he describes as taking place through the introduction of the mouth parts of the male into the genital pore of the female. The writer has observed this same habit in *Ixodes scapularis,* both upon and off the host. An unengorged, unattached female taken in the field from a hunting dog and placed in a pill box with unattached males taken from the same dog was shortly after found in copulation with one of the males. From this it would appear that it is unnecessary, for the female of this species at least, to take food prior to fertilization. The habit of fertilization through the introduction of the male mouth parts into the genital opening of the female thus appears to be typical of the genus *Ixodes.*

Geographical Distribution.—While ticks are found which have adapted themselves to colder climates, it is in the tropics that they are found in the greatest numbers. That the distribution of species is controlled by cold is well illustrated by the original quarantine line against the cattle tick in this country. Humidity and precipitation also appear to be factors in control of the distribution, as in the case of the Gulf Coast Tick, *Amblyomma maculatum,* a species found in the immediate vicinity of the Gulf Coast from Cameron Parish, Louisiana, to the Rio Grande River in Texas.

Life History and Habits of the Genera and Species.—The life history and habits of the *Argasidae* are quite different from those of the *Ixodidae*. The Argasids are represented by the two genera *Argas* and *Ornithodoros*, the species being comparatively few in number. Some of these, known as man-attacking ticks, have had the reputation from the effect of their bites of producing critical conditions. Livingstone, in the account of his travels in Africa, speaks of the ofttimes serious symptoms and occasional fatal result following their attack. Lounsbury in the investigation of this effect permitted specimens of *Argas persicus* and *Ornithodoros savignyi* (the Tampan Tick), two species implicated, to feed upon his arm, and concludes that while they may be productive of considerable irritation and their penetration serve as entering point for some of the abscess-forming bacteria, as *Streptococcus pyogenes*, etc., yet otherwise their direct effect is harmless. They may, however, transmit disease in both man and the lower animals. Dutton and Todd have shown *Ornithodoros savignyi var caecus* (*moubata*) Neum. to be the agent in the transmission of a spirillum which produces a disease of man known as human tick fever. This may account for the reputation that they have borne in Africa.

In the genus *Argas* the nocturnal habit is developed. They remain hid away by day, coming out from their places of hiding by night to find the fowl host and engorge with blood. The genus is represented in this country by two species, *sanchezi* and *miniatus*. Of the former species, known as the Adobe Tick from its habit of frequenting adobe houses, little or nothing is known as relating to its life history. *Argas miniatus*, commonly known as the Fowl Tick, is a species very similar in structure, life history and habits to that of the old world *Argas persicus*, and is probably at most but a variety of that species. The life history and habits have been carefully worked out by Lounsbury in South Africa and the similarity of our species in life history and habits has been determined by the writer. *Argas miniatus* is of importance because of its attack upon poultry; in sections of Southwestern Texas it has made profitable poultry raising impossible. As a larva, this tick attaches to a fowl, preferably beneath the wings, remains attached for five or six days, becomes engorged, and, a few hours before dropping, flattens out and assumes the typical Argas shape. As mentioned in the discussion of host relationship, it has been found that the larvæ drop only at night, at a time when the fowl host is upon the roost and where it will be near the host when ready to engorge again. In summer a period of four or more days passes before molting of the engorged larvæ takes place and the eight-legged nymphs appear. The second engorgement, always at night, lasts but a few hours at the

most and is followed in summer by five days before the second molt and the appearance of the second stage nymph. A third engorgement occurs at night (in the latter part of August) and twenty-six days pass before any of the ticks molt and appear as adults. A fourth engorgement then takes place, the sexes copulate and eggs are soon deposited. Unlike the ticks of all other genera, so far as known, these ticks re-engorge a number of times as adults, and the re-engorgement is followed each time by oviposition. The eggs hatch in summer in about fifteen days. The longevity of these ticks and their resistance to insecticides is remarkable.

The genus *Ornithodoros* is represented in this country by the two more common species *turicata* and *megnini* and two but little known species, *coriaceus* and *talaje*. But little is known of the life history of *turicata*, which Lounsbury suggests as being identical with the African species *savignyi*. *Ornothodoros megnini*, known as the Spinose Ear Tick, from spines of the nymph and its habit of infesting the ear, is a species found frequently in some parts of the South in the ears of cattle, horses, sheep, and a few other animals. The life cycle, which has been followed by the writer, is found to be this: Seed ticks, having gained entrance to the ear, attach deep down in the folds, engorge, and in about five days molt; as nymphs with their spinose body they appear entirely unlike the larvae. As nypmhs they continue feeding sometimes for months. In experiments made by the writer the first nymph to leave had remained in the ear thirty-five days from the time it entered as a seed tick; others still remain in the ears at the time of writing (December 7th), a period of ninety-eight days having passed since they entered as seed ticks. After leaving the ears as nymphs, these ticks usually crawl up several feet from the ground and secrete themselves in cracks and crevices, where, in about seven days in September, after leaving the ear, they shed a membranous skin and appear as adults without the spines. Fertilization then takes place and oviposition commences, the female dying with its completion. Unless fertilization takes place, eggs are not deposited and the ticks live for a long period. The incubation period in summer is as short as eleven days. Owing to their habit of remaining for long periods in the ears, they can be carried great distances. This fact may account for their being reported from some of the northern states.

The second family, the *Ixodidæ* or typical ticks, is represented in this country by nine genera, including thirty recognized and described, and several undescribed, species. The life cycle of species of the genera *Margaropus*, *Rhipicephalus*, *Dermacentor*, *Haemaphysalis*, *Ixodes* and *Amblyomma* has been followed. The greater number of these drop to pass both molts off the host. Of the species found in

this country *Margaropus annulatus* and *Dermacentor nitens* pass both molts on the host and a species of *Haemaphysalis,* found in Texas, Lousiana and Florida upon birds, has been determined by the attached molted skins to pass at least the first molt upon the host. In the species which molt upon the host, molting closely follows engorgement, but in the species which drop to molt there follows a quiescent period of two weeks or more.

All species of the genus *Margaropus,* so far as known, pass both molts upon the host. The single species of the genus found in this country, *annulatus,* attaches to cattle, horses, mules, donkeys, deer, and occasionally to sheep, goats and dogs. The larvae following attachment engorge to repletion and molt in six or seven days; then follows a similar period of engorgement as a nymph and another molt. Appearing as an adult, the male searches out the female, and copulation continues until the engorged female drops, which may be as soon as five days after molting. In summer deposition commences in three days after dropping and an incubation period of twenty-one to twenty-five days follows.

Most species of the genus *Rhipicephalus* pass their molts off the host, as is the case with the species found in this country. Lounsbury, however, has found that a South African species, *Rhipicephalus evertsi,* passes the first molt upon the host. The Brown Dog Tick, an undescribed species near *sanguineus* and the sole representative found in this country, engorges as a larva and drops in from three to seven days following attachment. A quiescent period of twenty days as the minimum was found to be passed at Dallas in October before molting commenced. As nymphs a period of engorgement of four days or more is passed before dropping occurs; this is followed by a quiescent period of fourteen days in October, when molting commences. As in *Margaropus* the male searches out the female and remains in copula until she drops, engorgement of the adult female taking about a week. Deposition of eggs commences in three or four days after dropping. At Dallas eggs deposited May 17th commenced hatching in twenty-five days. The usual host of this species is the dog, so far as is known, no records of other hosts having been made.

In the genus *Dermacentor* we find species of the two classes, i. e., those which drop for both molts and those which pass both molts on the host, the first represented by *occidentalis* and *variabilis* and the latter by *nitens.* Doctor Ricketts has determined this habit in *occidentalis* from material collected in Montana and has furnished some additional data on their habits.* He reports horses and cattle as hosts in Montana. It has been determined by the writer at the

*Journ. Amer. Med. Ass'n, p. 1069 (Oct., 1907).

Dallas laboratory that *Dermacentor variabilis* in the larva stage, attach, engorge and commence dropping in four days; a quiescent period of seven days or more passes before the molt takes place. The nymphs then engorge in about five days and pass a quiescent period of seventeen days (in September at Dallas) before molting. Considerable difficulty has been experienced in getting adults to attach and engorge, owing probably to a failure to understand what Lounsbury calls the courtship. A male that had previously fed and a female unfed were confined upon the scrotum of a bovine on November 1st; these attached and reattached a number of times, but up to November 14th had not been found in coito, though examined twice daily. On November 14th the female, having nearly fed to repletion, was found in copulation with the male, remaining in this relation for about twenty-four hours, but separating a number of hours before dropping. Dropping took place on the 15th, a period of over two weeks from attachment. Professor Morgan, however, reports that he has found the female to engorge in from five to eight days. The incubation period of eggs deposited the latter part of June was twenty-seven days. This species usually chooses the dog as its host, although it has been found upon a number of other mammals. *Dermacentor nitens*, the Tropical Horse Tick, a species found in Texas from Brownsville to Corpus Christi, has been determined as passing both molts upon the host. It is found largely in the ears, although from lack of room it sometimes attaches in the mane of the horse. The horse is the common host, although a few specimens have been taken from the ear of the goat.

Two species of the genus *Haemaphysalis, leporis palustris,* the Rabbit Tick of this country, and *leachi*, the Dog Tick of South Africa, pass both molts off the host. There is a species of *Haemaphysalis* found throughout the South, upon quail and other birds that feed upon the ground, which, although its life cycle has not as yet been followed, has been determined by the writer as passing (at least occasionally) the first molt upon the host. This species may prove to be *leporis palustris,* which is found so commonly upon the rabbits (with a somewhat changed habit of molting) or it may be *chordeilis*. This will soon be determined, but as yet the adults have not been obtained. The life cycle of *Haemaphysalis leporis palustris* has been partially followed by the writer at Dallas and the part remaining will soon be completed. The larvae engorge and commence dropping on the fifth day from attachment; in October they were found to remain quiescent eighteen days before molting. Nymphs attached and engorged in six days, those dropping November 4th not having molted at the time of writing (December 7th). It has been determined by large numbers of larvae

and lesser numbers of nymphs to be the habit of the engorged stages to drop during the day time. As mentioned under host relationship, this appears to be a remarkable adaptation to the habits of the host on the part of the tick. It is the habit of the hares and rabbits to remain during the day time in their resting places, which are commonly known as "forms." These forms are made by scratching in the grass beneath weeds or brush and furnish protection from the sun and enemies, such as the birds of prey. At night they become active, being protected from enemies by the darkness. Thus it is seen that the ticks by dropping during the day time in or near these forms readily find the host after hatching or molting.

In the genus *Ixodes* the life cycle of but a single species has been followed, that of *Ixodes ricinus* by Wheler in England. While there are fourteen species reported from this country, but few have been collected by agents of the Bureau, and these only occasionally. In Florida the writer has found *Ixodes scapularis* to be quite common on dogs, but because he was not acquainted with the fact that the members of this genus require more moisture than most other ticks, these died without development. Wheler finds *Ixodes ricinus* to drop for both molts, as is probably the case with the other species of the genus. He reports the larvae to engorge and drop in two days; that in winter (February to April) eleven weeks pass before they molt. Of the periods of engorgement of the nymph and adult we are not informed. Engorged nymphs removed May 29 molted three weeks later and an engorged female removed April 15 commenced oviposition on the 27th day following. While this species occurs in this country, it has been taken but once in Texas by agents of the Bureau, although extensive collections of ticks have been made. Immature stages of an undetermined species have been taken from the heads of birds by the writer.

The species of the genus *Amblyomma*, the life cycles of three of which *(americanum, cajennense* and *maculatum)* have been followed by the writer and that of the South African species *hebraeum* by Lounsbury, all appear to drop to molt. The genus is represented in this country by four species, the three mentioned and *tuberculatum*. Aside from *tuberculatum*, which has been found only on the land turtle in Florida, the species are not closely restricted in their host relations. The Lone Star Tick, *Amblyomma americanum*, as larvae engorge in three days, drop and commence molting eight days later; as nymphs similar periods are necessary for engorgement and molting: as adults eleven days was the quickest period in which engorgement and dropping took place. After dropping, at least eight days were found to pass before oviposition commenced. The minimum incubation period recorded is for eggs deposited June 25, when 27 days

were necessary. The Gulf Coast Tick, *Amblyomma maculatum,* as a larva engorges and drops as soon as the third day from attachment, and in the latter part of September, eleven days were necessary for molting. As nymphs, five days were necessary for engorgement, ticks that dropped November 3d not having molted at the time of writing (December 7). This species is the largest found in the United States. When fully engorged it measures two thirds of an inch in length. It also deposits the largest number of eggs, those from one specimen recorded numbering 11,265. The Cayenna Tick, *Amblyomma cajennense,* as a larva engorges and drops on the third day, following which eleven days are necessary before molting takes place. As a nymph, three days as in the larva were necessary for engorgement, and fifteen passed before they molted. The adult was found to engorge and drop in seven days. The incubation period of this species seems to be much longer than that of the other two native species studied, eggs deposited the latter part of May requiring five weeks before hatching commenced.

The species of the genus *Ceratixodes* are apparently all parasites of marine birds, little or nothing being known as to their life history and habits. *Ceratixodes signatus* Birula was described from specimens taken from Alaska. It has since been taken from cormorants in California. *Ceratixodes putus* Camb. has also been recorded from Alaska. Banks now considers *Ceratixodes borealis* K and N, a synonym of *putus.*

The Methods Used in Breeding Ticks.—So far as possible the usual host should be used in determining the parasitic periods in order to eliminate any possible variation from the normal condition.

In the ticks which pass both molts upon the host, as does *Margaropus (Boophilus) annulatus,* it is a comparatively easy matter to follow the life cycles, but in the species which drop from the host to molt, as do most of our North American species, it is much more of a task. In these species we must succeed in getting the same individuals to attach to the host and catch them as they drop, three separate times. After dropping each time they must be confined under favorable conditions and frequent examinations made to determine the normal periods of molting and oviposition and the variations therefrom. These periods as well as the incubation period vary with the temperature. In order to present satisfactory information upon these periods, they should all be recorded in connection with the thermometric readings. Thus the following data should be recorded: locality bred, date of dropping or oviposition, date of molting or hatching, total period and total effective temperature. With such data at hand, information from studies in the South can be applied in the North.

The methods found the most satisfactory for the species attaching

to cattle is that suggested by Professor Lounsbury, of attaching a bag to the scrotum of a bovine. In this way the various stages of the ticks can be applied, examinations made and the ticks removed as they drop. All of the Ixodids thus applied by the writer have attached. Some species, however, *Dermacentor variabilis* in particular, attach with considerable reluctance. In this way by removing the bag and with it the unattached ticks at the end of a given period and then making examinations twice daily and removing the engorged ticks from the bag (which has been re-attached), the exact periods of engorgement can be determined. In order to prevent the removal of the bag from the scrotum, a harness has been arranged and will be found necessary.

In determining the life cycle of ticks that attach to small animals, such as dogs, rabbits, squirrels, fowls and others, the only satisfactory arrangement found has been a cage made of wire of about one fourth inch mesh, permitting the ticks to drop through into a pan beneath. This cage made of a wooden frame should have the joints set in white lead or putty in order to eliminate all possible hiding places, into which the ticks might crawl for protection. Nails inserted in the frame serve as good posts, preventing the ticks from crawling again to the cage. In the pan or tray under the cage may be placed strips of paper beneath which the ticks will crawl. It has been the practice to place a ring of white axle grease about the rim of the pan or tray to prevent the escape of any of the ticks which have dropped. Another way of preventing their escape is by setting this pan or tray in a larger one filled with water. When the examinations are made the tray can be removed, the ticks collected and the cage cleaned with little difficulty. The plan of this tray was first suggested to the writer by Professor Lounsbury and is similar to that which he has used.

Many ticks will molt when but a small amount of moisture is supplied, whereas others, as the species of the genus *Ixodes*, require much more. As the engorged ticks are removed from the bag or tray, it has been found that favorable conditions are furnished by placing them in pill boxes upon moist sand. These pill boxes are prepared by puncturing the tops and bottoms, or better yet, furnished with gauze tops, to permit of free circulation. Still more favorable conditions are furnished by inserting in sand test tubes from which the bottoms have been removed. As stoppers for the tubes, absorbent cotton will largely prevent too humid an atmosphere, if protected from rains. A large tray has been used filled with sand into which the tubes have been inserted and on which the pill boxes have been kept. By sub-irrigation the amount of moisture furnished can be kept nearly constant without interfering with the pill boxes. This sub-irrigation is best furnished by use of a large cylinder tube extending to the bottom of the

sand; water poured into this will gradually percolate through and moisten the sand.

For longevity experiments ticks are best kept in this way, observations being readily made through the glass without disturbing the ticks. These tubes may be kept outside inserted in the soil and the longevity of the stages determined under the prevailing or normal climatical conditions which, however, are not always the most favorable to longevity. In determining the longevity of ticks on grass and weeds, a screen cage is necessary to assure protection from accidental intrusion.

The life history of the Spinose Ear Tick, *Ornithodoros megnini*, has been determined by attaching to the ears of animals bags held in place and prevented from being rubbed off by tying to a cord about the horns.

SOME LIFE HISTORY NOTES ON THE SOUTHERN CATTLE TICK

(Illustrated with Lantern Slides.)

By E. C. Cotton, *Knoxville, Tenn.*

(Withdrawn for publication elsewhere.)

A TENTATIVE LAW RELATING TO THE INCUBATION OF THE EGGS OF MARGAROPUS ANNULATUS

By W. D. Hunter, *Bureau of Entomology, U. S. Department of Agriculture.*

Studies of the effects of temperatures upon insects have always held great interest and have frequently led to results of practical value. In this country the principal work has been done by Dr. L. O. Howard, who in 1896 in a paper read before this Association, "Some Temperature Effects on Household Insects,"[a] pointed out exactly how cold storage practice could be utilized in the control of certain species. A year before, the same entomologist had shown the probabilities of the restriction of imported injurious species to certain life zones which, of course, are predetermined by temperatures.[b] Later Doctor Howard in his paper on the geographical distribution of the yellow fever mosquito made much the most interesting and important contribution to the subject.[c] He showed how the range of *Stegomyia calopus* was determined by temperature and how the exact limitations of the regions in which this mosquito, if accidentally introduced, might be expected to become perfectly established, could be determined by computing the accumulated effective temperature.

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[a]Bul. Bur. Ent. 6, p. 13-17. [b]Proc. Ent. Soc. Wash. 3: 219-226.

[c]Public Health Rep'ts, 18, No. 46.

The possibility of controlling Bruchids in stored cow-peas was shown in 1905 by Mr. J. W. T. Duvel.[e]

Prof. E. D. Sanderson in 1905 proposed a hypothesis regarding the determination of the time of maximum emergence from hibernation of the cotton boll weevil.[d] The proposed rule was based upon the departure of the temperature from the normal. The maximum emergence would be later or earlier than the normal time as the accumulated temperature would be lower or higher. The work on the boll weevil has furnished another example. Mr. W. O. Martin, formerly associated with Mr. Wilmon Newell, devised an ingenious method of determining the time when weevils in the dispersion movement had arrived in any certain field.[f] Previously it has been shown by Dr. W. E. Hinds and the writer that the growth of the weevil larva was regulated practically absolutely by effective temperatures and the amount of temperature necessary for the development of the different stages has been determined. Therefore the age of any weevil stage found in degrees of effective temperature was known. It only remained to sum up the daily effective temperature, going backward from the day upon which the specimens might be found until the total equalled the known amount necessary for that stage. The date thus obtained, of course, was the one upon which the parent weevil had reached the field.

There are two respects in which the cattle tick is conspicuously affected by temperatures: (1) its distribution in this country is limited; and (2) in a large portion of the natural range the eggs while not destroyed are prevented from hatching for several months during the winter. Attention was called by Doctor Howard to the restricted distribution of the tick and the close correspondence of its range to that of the yellow fever mosquito. In the present paper, however, we are concerned with the second feature, namely, the long deferred hatching due to low temperatures.

In work relating to the cattle tick, in which the writer is associated with Mr. W. A. Hooker, it was found that the total effective temperature required for hatching varied from 840 to 1510 degrees F. The shortest incubation period was found when the accumulated effective temperature was highest and the longest incubation when the accumulated effective temperature was lowest. That is, the incubation period varied inversely with the accumulated effective temperature. Now, obviously the reason for the variation is the daily mean temperature. In other words, incubation takes longer in winter than in summer. What was desired then was to determine the rela-

[d]Bul. Bur. Ent. 52, p. 29–42. [e]Bul. Bur. Ent. 54, p. 49–54.
[f]Cir. La. Crop Pest Comm. 9, p. 23–27.

tion between the daily mean temperature and the total effective required for hatching. An examination of careful records kept by Mr. Hooker extending over two entire years enables us to formulate the following tentative law: When the average daily mean temperature ranges less than 53.2 degrees, at least 1,510.8 degrees of effective temperature must accumulate before hatching will take place. When the mean daily temperature averages from 61.4° to 77.8°, from 840.5 to 1,139.1 degrees of effective temperature will be required for hatching. When the mean daily temperature averages higher than 80 degrees, between 782.7 and 824.3 degrees of effective temperature must be accumulated before hatching will take place.

Practical Application.—In approximately one-half of the normally tick infested area in this country no eggs deposited after about the middle of September hatch until some indefinite time the following spring. The cultivated fields (and those from which cattle have been kept for some time) in this large area are absolutely free of ticks every fall. Infested cattle will soon lose their ticks when placed on such areas and will not become reinfested with the progeny of the dropped individuals until such time as the eggs may hatch. The law proposed will tell the farmer how long the cattle may remain without danger of infestation. There has been an indefinite rule to let cattle remain in such cases "until spring," but some seasons they should be removed in February and in others the pasture could be continued in use until May. One of the most important difficulties in the rotation system of freeing cattle of ticks is that farms are generally overstocked. The rule proposed will tend to minimize this obstacle by showing how pastures may be utilized until the latest safe date.

The following is proposed as the most feasible plan in placing the necessary information in the hands of farmers: let the state entomologist keep records of the daily mean and effective temperatures (or obtain them from the Weather Bureau) beginning with, say September 15 and starting separate computations at regular semi-monthly intervals. These dates will stand for the time when any farmer may have placed cattle in tick free areas. When the proposed law shows that the time for eggs to hatch is approaching, notice could be issued in the press. Such a notice might read in brief as follows: Farmers who placed cattle in tick free areas between September 15 and 30 should remove them by February 15; there is no danger of reinfestation of cattle placed on tick free pastures during October and will not be until further notice is given.

It is not at all improbable that individual ranchers could apply the rule by means of data obtained on their own places. In such

cases, the results would be more exact because computations would begin on the exact date cattle were placed in the pastures, while those made in the office of the entomologist would necessarily be more or less generalized. The only apparatus necessary for the ranchman would be a set of maximum and minimum thermometers and the only work involved, the keeping of the record of the average daily mean temperature and the accumulated effective temperature from the date the cattle were placed on the tick free area.

Possible Criticisms.—The criticism might be made that studies referred to in the foregoing do not take into consideration factors other than temperature which might influence incubation. Among these might be mentioned: (1) moisture; and (2) accidental heat, as for instance from manure piles. Regarding moisture, it may be said that tick eggs are susceptible. A certain degree of dessication absolutely prevents hatching. Nevertheless our data have been drawn from eggs placed under a variety of conditions and due allowance has been made in the law for the usual seasonal variations. Our figures are not from individual lots of eggs, but averages from many lots under different conditions. The accidental heat from manure referred to at most could be but an exceedingly unimportant matter. About barns it might be worthy of consideration, but in pastures for all practical purposes it would be absolutely negligible.

There is a margin for possible error in the temperatures that may occur between the time a prediction is made and the actual time of hatching. Unusual variations may lengthen or shorten this interval. This obviously will always make it impossible to predict the exact time of hatching. Nevertheless, close approximations can be madė and these will serve every practical purpose. The entomologist can always take pains to be on the safe side by allowing for the highest temperatures known for the period between the date of the prediction and the forecasted date of hatching.

In conclusion, it seems that the present proposed law is at least as tangible as any temperature law proposed with reference to insects. Strictly tentative as it is and subject to possible important modifications or even absolute nullification as the result of further data, at this time it seems to have practical possibilities. Though not as important as Doctor Howard's rule regarding the yellow fever mosquito, it is at least as definite, for the factors that could possibly vitiate it are no more important than in that case. On the other hand the law cannot be as exact as Wallich's rule governing the hatching of fish eggs, because in that case all the varying influences of the air are absent and replaced by less important ones in the water.

The law dealt with in this paper was given preliminary notice in

bulletin 72, Bureau of Entomology, U. S. Department of Agriculture, page 20. Much additional data has been obtained since the publication of that bulletin. The work is being continued and further results will be recorded from time to time.

In discussing these papers Mr. Hooker called attention to the lantern slides exhibited by Mr. Cotton, which showed the large number of eggs deposited by the North American Fever Tick. This holds true with all Ixodid ticks, as they literally manufacture eggs from the blood with which they become engorged. Comparatively few of the seed ticks find a host, the majority dying from starvation, otherwise all animal life would be covered with ticks. The largest ticks belong to the genus *Amblyomma*. The gulf coast tick, *Amblyomma maculatum,* is the largest found in this country and when fully engorged the female measures three fourth of an inch in length. He had counted 11,265 eggs that had been deposited by a single tick of this species. The bont tick, *Amblyomma hebraeum,* of South Africa reaches an inch in length when fully engorged and Prof. Lounsbury estimates that a single female will deposit 20,000 eggs.

Mr. Sherman called attention to the excellent work that is being done in North Carolina by the state veterinarian, Dr. Butler. By utilizing the known facts concerning the cattle tick, twenty counties had been freed from quarantine.

Mr. J. L. Phillips remarked that conditions in Virginia are quite similar to those in North Carolina and that the quarantine line is being pushed south very rapidly.

Mr. W. D. Hunter testified to the valuable work that is being done by Dr. Butler in North Carolina, but called attention to the delicate equilibrium in which this species exists in the northern range. The problem is more difficult further south, as in Texas, where the ticks persist all winter.

Dr. Howard remarked that the Texas cattle tick is a tropical and lower austral species and that it can undoubtedly be controlled more easily when outside its normal range.

Mr. Sherman said that probably the results would be more slowly accomplished in the southern part of the state, nevertheless he considered that the results secured were exceedingly encouraging.

A paper was presented by Mr. Sanderson:

THE RELATION OF TEMPERATURE TO THE HIBERNATION OF INSECTS

By E. D. SANDERSON, *Durham, N. H.*

Three years ago at the Philadelphia meeting of this association the writer advanced a hypothesis for determining the time of maximum emergence of the Mexican cotton boll weevil. Subsequent observations by others have tended to discredit the correctness of the method then advanced, but it served to call attention to the fact that "the time of emergence of insects from hibernation and the date upon which they begin oviposition or normal activity is dependent upon well-defined physical laws" which should be determined, and the writer is of the opinion that careful study of the large amount of data now accumulating concerning the time of emergence of the boll weevil will reveal the laws governing the time of its appearance.

Since then, with the aid of assistants and students, I have made a number of experiments principally with the tent caterpillar (*Malacosoma americana*), the brown-tail moth (*Euproctis chrysorrhoea*), and the codling moth (*Carpocapsa pomonella*), in an endeavor to determine the relation of temperature to the hibernation of insects. Only a beginning has been made and as we get deeper into the subject we find that it is an exceedingly complex one and is closely bound up with fundamental problems of physiology and heredity. There are a few points, however, which may well be brought to your attention at this time.

It has been customary in the study of meteorological and biological data concerning temperature to use the mean daily temperature in accumulating the amount of temperature involved in any phenomena. But it is evident that if the day be cloudy and the sun shine for a short time at noon that the mean for that day will be much higher than the actual mean temperature which occurred during that day. We have therefore resorted to the use of recording thermographs of the Reichard or Short and Mason type, such as are in use by the U. S. Weather Bureau, which, with frequent standardization, show the actual temperature for the whole day. The polygon covering the temperature for the day is then measured with a polar planimeter and the actual mean temperature for the day is thus secured. It is found that frequently a difference of ten degrees occurs in greenhouses between the mean secured from the maximum and minimum and the true mean thus secured with a thermograph. Such records are especially important where a glass house is being used for experiments, and it would seem that this is the only accurate method of recording temperature where an exact study of temperature is desired for bio-

logical work, if not indeed for meteorological studies. The weekly sheets are readily filed and the temperature which occurred at any time during breeding experiments can thus be readily referred to or computed in the future.

We have been endeavoring to determine whether there be a "thermal constant" which governs the emergence of insects from hibernation. The "thermal constant" for insects may be defined as *that accumulation of mean daily temperature above the "critical point" of the species, which will cause it to emerge from hibernation or to transform from any given stage.* The "critical point" above which the temperature is accumulated is a matter of vital importance and seems to have been largely neglected in entomological work. European botanists have established the critical points of a long list of plants and shown that a large variation exists between species.[a] The "critical point" may be defined as that point of temperature above which active metabolism occurs and above which the accumulation of temperature affects the time of definite transformations in the organism, such as the leafing and flowering of plants, and the emergence from hibernation, hatching and transformations of insects. In recent studies of the relation of temperature to insect life it has been assumed that all temperatures over 43° F. are "effective temperatures," or that 43° F. is the critical point. But the records based upon this assumption go to prove that the critical point varies and that it must be determined for each species before accurate conclusions concerning the relation of temperature to that species can be secured. Thus, as was pointed out by Simpson in his excellent studies of the Codling Moth, it was impossible for him to draw definite conclusions from a considerable mass of data published by him concerning the influence of temperature upon the duration of its various stages.[b] The same fact has been brought out by Hunter and Hooker in their recent paper on the North American Fever Tick in their study of the relation of temperature to the period of incubation.[c] In the case of the browntail moth, our present observations go to show that 34° F. is the critical point above which the temperature accumulates in determining the time of emergence in the spring. The critical point is doubtless much lower for northern species and much higher for southern species, and it seems quite probable that it may vary for the same species which has become acclimated to diverse climatic conditions. Thus the

[a]See Cleveland Abbe, First Report on the Relations Between Climates and Crops, Bulletin 36, U. S. Weather Bureau, 1905.

[b]See Simpson, Bulletin 41, Division of Entomology, Tables IV and V, pages 37–39.

[c]Hunter and Hooker, Bulletin 72, Bureau of Entomology, page 20.

tent caterpillar has but one generation both in the North and South, hibernating over winter in the egg, in which the larva is completely formed. The critical point must be much higher in the South, for the low temperatures which are effective in the North are rarely reached in the South.

The time at which insects enter hibernation in the fall is undoubtedly largely influenced by temperature, and in many species it may be the controlling factor, but there are many cases where hibernation commences before there is a material drop in temperature, and that the lowering temperature is the controlling factor is disproved by the fact that insects subjected to high temperatures before the normal time for hibernation persist in hibernating or else remain slightly active, but rest and do not feed or reproduce for a considerable length of time. This has been shown by Tower in his remarkable experiments upon the Potato Beetle and in our own experiments. This paper of Dr. Tower[d] will ever remain an entomological classic and should receive the study of everyone interested in economic entomology. Tower has shown that all of the beetles of this genus have two generations and no more, and that after the second generation there must be a time of rest before reproduction continues. In some cases this is hibernation and in others æstivation, which Tower maintains are practically the same as regards the life history of the insect. In both cases the insect prepares for the resting stage by losing about 30% of its gross weight through the loss of water, which enables it to withstand a lower freezing point and higher temperatures than if the protoplasm were not thus condensed.

In endeavoring to determine the thermal constant for emergence we have placed the hibernating stage in greenhouses heated at different temperatures and compared the amount of temperature accumulated in each up to emergence with that accumulating in nature. The first year the insects were not placed in the greenhouse until in January, after they had been subjected to considerable cold weather. They emerged in due time in a fairly normal manner. In 1906 the insects were brought into the greenhouse earlier in the season before they had been subjected to much cold out of doors. As a result it required much more heat over a longer period to force their emergence and they emerged irregularly for several weeks. Lots brought in later in the winter emerged much more normally. We were therefore led to suspect that the cold of winter had a positive influence in determining the length of the hibernation of these insects, which subse-

[d] W. L. Tower. Evolution in Chrysomelid Beetles of the Genus Leptinotarsa. Carnegie Institution, No. 48. 1906.

quent experiments have proven to be true. This fall we placed several lots in an icehouse and in cold storage for various lengths of time during August and September, at the same time placing other lots in glasshouses, where they never were subject to low temperatures. Those which were placed in cold storage have hatched, in the case of the tent caterpillar eggs in about two weeks, while those which have not been subjected to cold have not hatched yet. Several lots placed in storage and taken out at different times have proven this, and our experiments are arranged to show how long they must be subjected to low temperature and whether extreme low temperatures have any more effect or will reduce the time of hibernation more than those merely below the critical point. This fact had been previously shown by Weismann in his paper, "On the Seasonal Dimorphism of Butterflies" nearly thirty years ago,[e] when he described experiments in which by subjecting pupæ of the summer form of *Pieris napi* to refrigeration for three months and then bringing them into a hothouse he was able to secure the winter form by about October first, but in which he was unable to secure the immediate transformation of pupæ of the fourth brood of *Araschnia levana* (*prorsa*) by placing them in a hothouse as soon as the pupæ formed, for invariably nearly all hibernated over winter, even in the warm hothouse, and emerged in the spring as the winter form. It is evident that subjecting these hibernating forms to low temperatures has the effect of producing a more complete rest than when hibernation goes on at higher temperatures, and the time of hibernation may therefore be shortened in many instances by subjecting to cold before heat. It is interesting to note in this connection that the same effect as that normally sustained by freezing has recently been secured with rhubarb, various bulbs, lilac and other flowering plants, by anesthetizing them with ether. The exact effect of the ether has not been definitely determined, as far as I can ascertain from a cursory examination of the literature, but Dr. Loeb[f] has suggested that the effect is possibly related to the effect of cold upon chrysalids as mentioned above. If the effect of the ether is a drying process, as some claim, this seems possible.

In the light of these facts, may it not be possible to account for the fact that some insects have but a single generation in the South, while others have several generations? Thus the tent caterpillar, peach borer, plum curculio, canker worms, gypsy and brown-tail moths, and others, mostly insects affecting native fruits and seemingly indigenous

[e]August Weismann, Studies in the Theory of Descent, translated by Meldola. Eng. Ed. London, 1882.

[f]Loeb—The Dynamics of Living Matter. 1906, page 112.

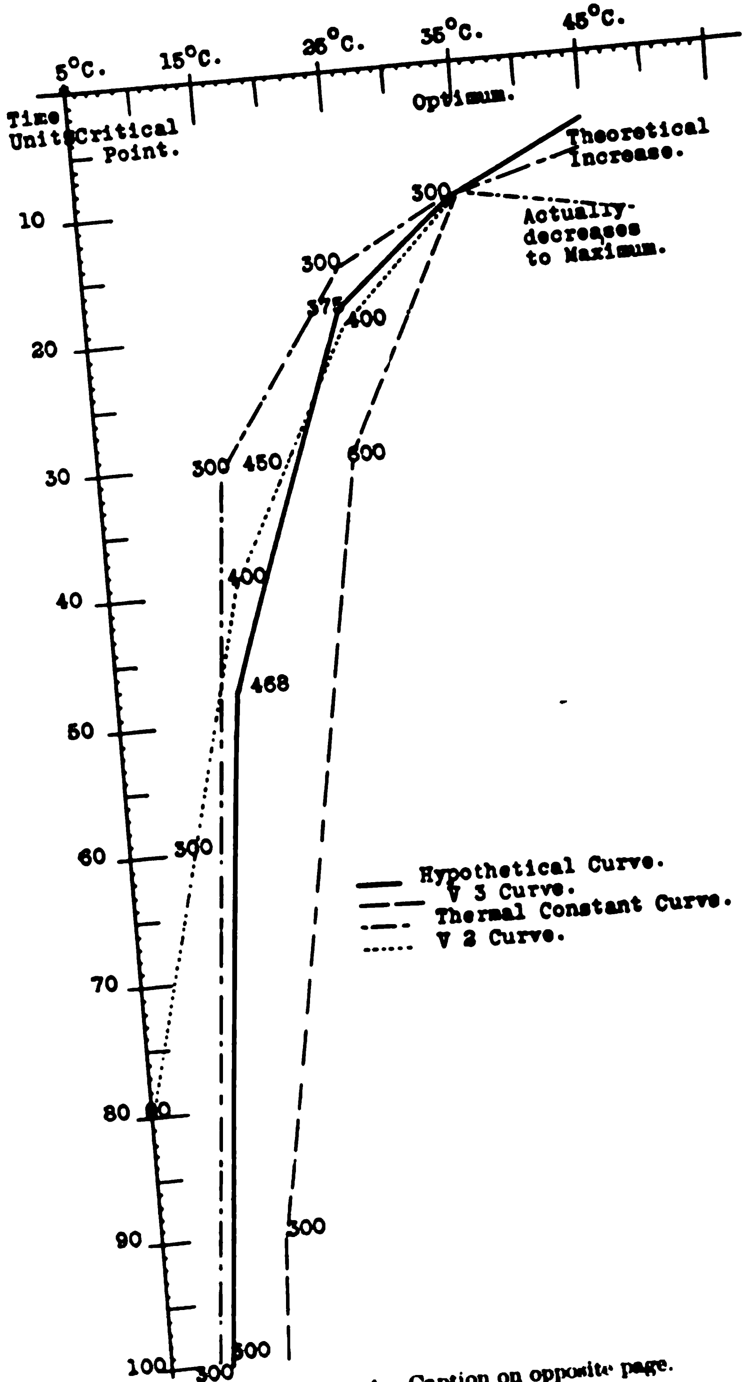

FIGURE 1. Caption on opposite page.

to north temperate climates, have but one generation in the South, while southern species have many generations in the South, but the number decreases as they spread northward. Why should not all have several generations in the South? I have been unable to find any investigations of this problem whatever and would be indebted for any data which will throw any light upon it.

In some cases, however, the time of emergence from hibernation is controlled by moisture conditions as well as temperature, or independent of temperature. Thus Tower kept the potato beetle in hibernation for 18 months at a high temperature but with a dry atmosphere, and they emerged as soon as normal moisture conditions were produced. Webster and Hopkins have shown a similar effect of lack of rainfall on the emergence of the Hessian Fly in the fall. In relation to hibernation in humid climates the matter of moisture is probably not a controlling factor, but undoubtedly has the most important influence upon the time of emergence of forms in æstivation during the summer or in arid regions.

A principle which should be considered in any attempt to fix a thermal constant is the law of the velocity of chemical reactions. In general, it may be stated that the velocity of chemical reactions doubles or triples with every increase of 10° C., or in other words, a reaction will take but one half or one third as much time with an increase of 10° C. The application of this law to the velocity of various phases of the physiology of animal and plant life is receiving considerable attention by physiologists at the present time and some of the observations made are shown graphically in figure 2. But all of the observations made go to show that this so-called law is only an approximation of the facts between certain degrees of temperature ranging within 15° or 20° C. of the optimum temperature of the form under study. At low temperatures the velocity rises very rapidly as temperature increases, and above the optimum the velocity decreases. The difference between the observed change in coefficient of increase of velocity as temperature rises, as shown by these curves, and the theoretical application of this law if the velocity doubled or tripled with every increase of 10° C. is shown by the difference be-

FIGURE 1. Curves showing the relation of increase of temperature to the time required for stages of growth of animals, more particularly as affecting the emergence from hibernation and transformations of insects. *Hypothetical Curve*, indicating the empirical nature of the curve of effect of temperature of individual species; *V 2 and V 3 Curves* based on uniform coefficient of increase of velocity of reaction of 2 and 3; *Thermal Constant Curve*, based on thermal constant of 300°C. Numbers on curves are the thermal constants in degrees Centigrade at points marked. Optimum of 35°C. is empirical and varies for each species.

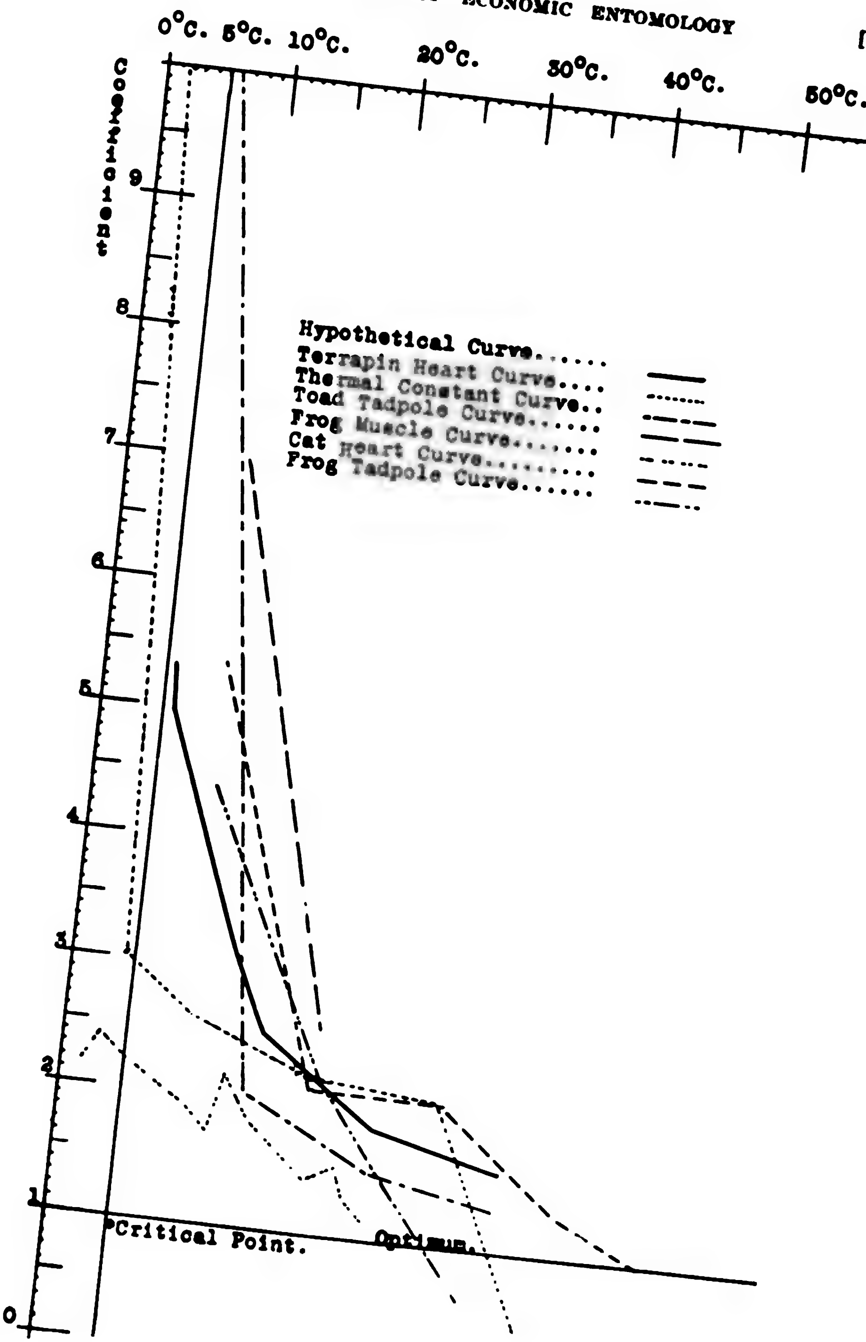

FIGURE 2. Caption on opposite page.

tween these curves and a horizontal line at 2 or 3, which would represent the plotting of the increase of velocity, were it uniform between the critical point and maximum.

If there be a thermal constant for all temperatures between the critical point and maximum, it would be represented by a curve like "T. C. C." in figure 1. But there is evidence to show that the thermal constant is lower at the optimum than at temperatures approaching the critical point. And if the velocity be plotted from the curve "T. C. C." of figure 1, the same curve in figure 2 shows that the coefficient of increase of velocity with a uniform thermal constant is much less than that observed, being only 1.5 at 25° C. On the other hand, if we plot a curve based on a uniform increase of velocity of a coefficient of 2 or 3 we secure curves V2.C. and V3.C. of figure 1, respectively, and by computing the thermal constant for various temperatures on these curves, it is found that the thermal constant increases below the optimum to a certain point and then decreases. Thus on V2.C. the thermal constant at 35° is 300, at 25° is 400, at 20° is 450, and then decreases to 400 again at 15°, to 300 at 10°, and at the critical point we secure the anomaly of a thermal constant of 80°, which is clearly impossible, as no reaction will take place unless above the critical point. The same would hold true of curve V3., or any other curve based upon a uniform coefficient of increase of velocity.

From a study of these considerations it seems probable that the effect of temperature upon various forms of animal life will be represented by a curve characteristic for each species or group for the various phenomena of growth considered, and that such a curve will be between the curve shown in figure 1 for the uniform thermal constant, T. C. C., and that for a uniform rate of increasing velocity, V2.C. Such a curve may be secured by a uniform coefficient of increase for the thermal constant as the temperature decreases from the optimum as shown in curve H. C.—hypothetical curve—figure 1.

FIGURE 2. Curves showing variation of coefficient of velocity of certain biological phenomena. *Hypothetical Curve*, based on same in figure 1; *Terrapin Heart Curve*, based on rate of heart beat of Pacific terrapin, from data by Snyder[a]; *Thermal Constant Curve*, based on same in figure 1; *Toad and Frog Tadpole Curves*, based on rate of growth of toad and frog tadpoles from data of Lillie and Knowlton[b]; *Frog Muscle Curve*, based on rate of contraction of gastrocnemius muscle of frog from data of Burnett[c]; *Cat Heart Curve*, based on rate of beat of isolated cat hearts from data of Langendorff[d].

[a] Snyder, Univ. Calif. Publications, Physiology, 2, pp 125. 1905, quoted by Arrhenius, Immunochemistry, pp 189.
[b] Quoted by Morgan, Experimental Zoology, pp 260.
[c] Burnett, Jour. Biological Chemistry, 2, pp 200-1906.
[d] From Snyder, Amer. Journal Physiology, 17, pp 356-1905.

In this curve the thermal constant has been increased 25% for every decrease of 10° from the optimum or with a uniform coefficient of 1.25. Upon plotting this curve it is found that the thermal constant increases uniformly toward the critical point, but that it would approach the critical point to infinity. Upon plotting the curve of the coefficients of increase of velocity of such a curve, the curve H. C. of figure 2 is secured, which corresponds very closely with those secured from actual observations.

But if there be such an empirical temperature curve for each species or phenomenon, it is evident that there can be no thermal constant which will be constant at all temperatures, for it increases in a uniform ratio below the optimum. A constant may however be secured by reducing the increments of temperature for each unit of time to terms of the thermal constant at the optimum, which is therefore 1. Thus the values of one unit of time on the hypothetical curve, H. C., figure 1, would be 0.1 at 35°, the optimum, 0.056 at 25°, and 0.021 at 15°, etc. When by adding these values sufficient are secured to make 1, the thermal constant has been reached, equivalent to the thermal constant at the optimum temperature. To secure such values it would be necessary to secure the thermal constant at the optimum and at two or three constant temperatures below, upon which the curve of the species or phenomenon might be plotted and the values for each degree of temperature for one unit of time calculated.

At present this is, of course, largely a hypothesis, but it accords with all the facts which have come under our observation, and seems worthy of attention by those who are engaged in study of the relation of temperature to insect life; for without hypotheses what could we accomplish in such work? During the coming year we hope to definitely determine this matter by rearing large numbers of two or three common household pests in specially constructed apparatus which will maintain constant temperatures, and thus enable us to secure the thermal constants for various temperatures, which may then be compared with the amount of temperature accumulated with varying temperatures.

It may seem to some that such studies are of rather remote importance to practical economic entomology, but as such work accumulates it becomes more and more evident that a positive knowledge of these fundamental factors governing the life of insects may have great practical value, and that entomology, as well as all biological science, must consider its relations to the more exact and fundamental sciences of physics and chemistry, if we are to have exact knowledge of the life with which we are dealing. Hunter and Hooker have recently suggested the practical application of such work in their study

of the relation of temperature to the incubation of eggs of the cattle tick and it seems probable that a similar application might be made in determining the time of treatment of the codling moth, though it is hardly probable that it will be necessary in the latter case.

But it is upon a positive and not merely hypothetical knowledge of such controlling forces as temperature that our science must rest and no one can foresee what entirely practical application may be made of it in the future study of new pests as they present themselves for study under new conditions.

The remainder of the proceedings of the 20th meeting of the Association of Economic Entomologists will be given in the next number of the Journal. It has been deemed advisable, in view of its close relation to two papers in this number, to publish at the same time Mr. Hooker's summarized account of our knowledge of the role of ticks in the transmission of disease. The paper was prepared originally for presentation at the meeting and as a part of the symposium on ticks, consequently it is very fitting that it should appear at this time.

A REVIEW OF THE PRESENT KNOWLEDGE OF THE ROLE OF TICKS IN THE TRANSMISSION OF DISEASE*

By W. A. Hooker, *Bureau of Entomology, U. S. Department of Agriculture.*

Not until within the last decade has the importance of insects and related animals as agents in the transmission of disease been fully appreciated. Within this period, however, the progress of our learning has advanced at an astounding rate. It was but fifteen years ago that Smith and Kilborne first demonstrated the role that the cattle tick, *Margaropus* (=*Boophilus*) *annulatus*, plays in the transmission of Splenetic or Texas Fever of Cattle, and only ten years ago that Ross first employed *Anopheles* in his mosquito-malaria experiments. Today we all know of the mechanical and biological agency of the flies and mosquitoes in the transmission of typhoid fever, cholera, anthrax or charbon, nagana or tsetse-fly disease, surra, malaria, yellow fever, filiariasis and dengue, and of fleas in the transmision of bubonic plague. Together and with the investigation of the Bacteriologist and Protozoölogist has come that of the Entomologist in the study of the life history and habits of the disease-carrying insects. We are all acquainted with the investigations in this country of Dr. L. O. Howard,

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*Prepared for presentation at the meeting of the Association of Economic Entomologists, held at Chicago, Illinois, Dec. 27-28, 1907.

Dr. J. B. Smith, Dr. E. P. Felt and others, supported by federal and state appropriations, making preventive treatment possible.

But it is to the *Ixodoidea*, or ticks, that I wish to call your attention in a brief review of our present knowledge of their role in the transmission of disease and to show that they are equally as imporant as the flies and mosquitoes in the transmission of disease. The object in preparing this paper is to emphasize the importance of the study of their biology and to encourage a more extensive collection of them by the Entomologist, within whose field of study they distinctly come.

That the importance of the investigations of the Entomologist are appreciated by the medical profession is well shown by the following paragraph taken from an address before the London School of Tropical Medicine by Sir Lauder Brunton,[1*] M. D., upon "Fleas as a National Danger," namely: "What is true of the G. *(lossina) palpalis* is true of other flies also, and as ticks and bugs are likewise most important as carriers of diseases there really ought to be established by government a chair, or, still better, an institute of scientific entomology, well endowed and having attached to it a number of men who could carry on original investigations. Such a chair, or institute, if thoroughly well endowed and having money lavishly expended upon it, would repay the expenditure a thousand-fold, for the study of tropical diseases is becoming to a great extent identified with the study of the insects which transmit them."

Professor C. P. Lounsbury, Government Entomologist of Cape Colony, may well be considered the pioneer in the study of the biology of the ticks. Prior to 1898, at which time he commenced their study, with the exception of the cattle tick, *Margaropus* (=*Boophilus*) *annulatus*, but little was known of their life history and habits. In speaking of their importance and of the opportunities offered in the study of this group, in a paper read before the British Association for the Advancement of Science[2] in 1905, he said, "To my mind the ticks present the more profitable field for the student, whether he be interested in the systematic classification of the species, in the determination of habits and metamorphoses, in experimental research in regard to their transmission of diseases, or in the development of pathogenic organisms within the body of intermediate hosts." In reviewing the status of our knowledge he said, "An excellent groundwork for the classification of the species has been made by Professor G. Newman in his *Revision de la famille des Ixodides*, which has been published in several parts by the Zoölogical Society of France during the last ten years; but very little has thus far been recorded on the internal anatomy of

*The numerals refer to bibliographical references at end of paper.

any species (for later work see following paragraphs), and so far as I am aware no one has yet traced the development of a disease organism within the body of a tick as has been so ably done in the somewhat analogous case of malarial organisms in *Anopheles* mosquitoes. Also very little has been recorded in regard to the habits and metamorphoses of any species other than those of the genus *Boophilus.*"

Since 1905, however, several valuable contributions have been added, including one upon the internal anatomy of *Margaropus annulatus* by S. R. Williams[4] and by W. E. Allen.[5] Mr. Nathan Banks of the Bureau of Entomology now has in manuscript a revision of the ticks of this country, which, when issued, will greatly aid in identification. Koch[6] has elucidated much of the life cycle of *Piroplasma bigeminum,* the cause of splenetic or Texas fever, and has succeeded in discovering the first stages of development of *Piroplasma parvum,* the parasite of African Coast fever, which are undergone in the tick. Christophers,[7] also Nuttall and Graham-Smith,[8] have followed the complete life cycle of *Piroplasma canis,* the cause of malignant jaundice of dogs.

Doctors Smith and Kilborne,[9] discovering in 1892 the role that the cattle tick, *Margaropus* (=*Boophilus*) *annulatus,* plays in the transmission of the protozoan, *Piroplasma bigeminum,* the blood parasite causing Texas fever of cattle in this country, paved the way for this new field of investigation. Since that time a number of diseases of man and the domestic animals have been found to be transmitted by these parasites. Subsequent investigation has shown that ticks are the intermediate hosts of species belonging to the disease producing protozoan genus *Piroplasma.* It has also been shown that several diseases produced by spirochaetæ are transmitted by ticks. The conclusions reached by Dutton and Todd[10] are that some development of the spirochaetæ of human tick fever takes place in the tick. Koch has found the spirochaetæ to multiply within the egg. Borrel and Marchoux[11] have found the spirochaetæ[b] of fowls to develop at 35° C. in the body of the tick.

In order to show the zoölogical position of these blood parasites (*Piroplasma*) transmitted by ticks, the following table taken partially from Daniels and Stanton's[12] most excellent work, is given:

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[b]There is still a difference of opinion as to the structure and relations of the spirilla and spirochaetæ. They have many similar characters but differ (according to some authors), the latter having flagellæ, which place them across the imaginary line from the former into the protozoa, thus being considered as animal life, while the spirilla are bacteria (or lowly organized plants.) Dr. Raphael Blanchard in the Revue Vétérinaire, 1906, p. 86, places all that are pathogenic in the genus Spirochaeta.

The exact position of some of the spirochaetæ is in question at present but they are believed to belong to the *Mastigophora*.

It seems probable that blood parasites exist in certain hosts without ill effect, such animals being naturally immune or having acquired immunity. When these organisms are transmitted to the blood of susceptible hosts, however, as are the various species of *Piroplasma*, a disease of more or less severity results. This is the case with the trypanosome of tsetse-fly disease, which Koch has found to be transmitted from the crocodile to man by the tsetse-fly (*Glossina* spp.). Again, while the organism producing Rocky Mountain spotted fever has not been discovered, yet Dr. H. T. Ricketts[13] has produced the disease in guinea pigs by ticks from horses, cows and vegetation and suspects its transmission from the blood of some animal which has served as host.

TABLE SHOWING THE ZOÖLOGICAL POSITION OF THE TICK TRANSMITTED PARASITES, PIROPLASMA SPP.

PROTOZOA.

Class (1) *Rhizopoda* (*Sarcodina*)

Class (2) *Mastigophora* Probably includes the Spirochaetae transmitted by the Argasid ticks as well as the Trypanosomes transmitted by flies of genus *Glossina*

Class (3) *Sporozoa*

Class (4) *Infusoria*

Sub Class *Telosporidia*

Sub Class *Neosporidia*

Order (1) *Gregarinoidea*

Order (2) *Haemosporidia*

Order (3) *Coccidiidea*

Genera

(1) *Plasmodium* (*Haemamoeba*) Including the malarial parasites transmitted by mosquitoes, of the genus *Anopheles*

(2) *Haemogregarina*

(3) *Piroplasma*
P. bigeminum
P. parvum
P. ovis
P. equi
P. canis
etc.
Transmitted by the Ixodinid ticks

(4) *Halteridium* (?)

THE FOLLOWING TABLE, AS ADAPTED FROM SEVERAL AUTHORS, SHOWS THE ZOÖLOGICAL POSITION OF THE TICKS.

SUB KINGDOM OR PHYLUM: ARTHROPODA

Class (1) *Onychophora* (2) *Myriapoda* (centipedes, millipedes, etc.) (3) *Insecta* (flies, mosquitos, gnats, fleas, etc.) (4) *Arachnida* (5) *Crustacea* crabs, lobsters, etc.)

Order (1) *Araneida* (spiders) (2) *Pedipalpida* (whip scorpions) (3) *Scorpionida* scorpions) (4) *Pseudoscorpionda* (book scorpions) (5) *Opilionda* or *Phalangida* (6) *Solpugida* (7) *Acarida* (mites, ticks)

Super Family (1) *Demodicoidea* (mites of the hair follicles) (2) *Ixodoidea* (ticks) (3) *Gamasoidea* (mites on beetles and other insects) (4) *Oribatoidea* (beetle like mites) (5) *Hydrachnoidea* (water mites) (6) *Sarcoptoidea* (itch mites) (7) *Eupodoidea* (the primitive mites) (8) *Trombidoidea* (running mites)

Family (1) *Argasidae*
Genus *Argas*
" *Ornithodoros*

(ticks which transmit Spirochaete and Spirillum (?)

(2) *Ixodidae*

Sub Family (1) *Rhipicephalinae*
Genus *Rhipicephalus*
" *Margaropus*
" *Haemaphysalis*
" *Dermacentor*

(2) *Ixodinae*
Genus *Ixodes*
" *Amblyomma*
" *Hyalomma*
" *Ceratixodes*
" *Aponomma*

(ticks which transmit *Piroplasma* spp)

Professor Lounsbury commenced the study of ticks in 1898. He first determined that heartwater,[c] a disease in that country of sheep, goats and cattle, which often proves fatal, is transmitted by the Bont Tick, *Amblyomma hebraeum*. The stimulus from this discovery has resulted in the determination that several diseases of animals in South Africa, besides red water or Texas fever, are thus transmitted, including malignant jaundice of dogs, African coast fever of cattle, and biliary fever of horses, mules and donkeys. Not only has it been demonstrated that these diseases are transmitted by ticks, but the species and the stages of each that are carriers of the pathogenic organisms have been determined.

The cattle tick of this country, *Margaropus* (=*Boophilus*) *annulatus*, now known as the North American Fever Tick, and its varieties found in other countries, all transmit *Piroplasma bigeminum*. In Europe, however, the European Castor Bean Tick, *Ixodes ricinus*, a species also found in this country, has been found to transmit the disease, imbibing the infection as an adult and transmitting it in the larval and nymphal stages following. As is generally known, the larva of the North American Fever Tick transmits the disease to susceptible animals when the previous generation has imbibed the infection, thus passing through the egg.

Lounsbury has found that in heartwater but one species, *Amblyomma hebraeum*, the Bont Tick, is concerned; as a larva it feeds on an infested animal, transmitting the disease in both nymphal and adult stages to a susceptible animal. The infection does not pass through the egg as with splenetic fever.

Malignant jaundice was found by Lounsbury to be transmitted from one dog to another by the Dog Tick, *Haemaphysalis leachi*. The infection is not transmitted by the larva or nymph, but by the adult alone and only when the adult of the preceding generation imbibed infectious blood. Ten was the smallest number of ticks that produced the disease in Lounsbury's experiments, although he concludes that a single pathogenic tick is probably ample to communicate infection that may lead to death. Christophers has found this disease in Madras, India, to be transmitted by *Rhipicephalus sanguineus*, and has followed the life cycle of the parasite, *Piroplasma canis*. Daniels and Stanton state that *Dermacentor reticulatus* transmits the disease in Europe, but I have not seen such record.

African coast fever, an extremely fatal disease of cattle in South

[c] In Cape Colony whole strips of country have become almost useless for sheep and goat breeding, as have certain districts in the Transvaal, due to heartwater.

Africa, was at first (1903) thought by Lounsbury to be transmitted by the Brown Tick, *Rhipicephalus appendiculatus*, alone, but further investigation has proven that four other species of the genus, *simus, evertsi, nitens* and *capensis* may also transmit it. The Brown Tick imbibes the infection as a larva or nymph and transmits it in the following stage of the same generation. In the adult stage both sexes transmit the disease, but one or two specimens being necessary. The infection does not pass through the egg.

Dr. Arnold Theiler,[14] Government Bacteriologist of the Transvaal, has found biliary fever or piroplasmosis of horses, mules and donkeys to be transmitted by the Red-legged tick, *Rhipicephalus evertsi*, one of the species found by Lounsbury to transmit African coast fever. The infection is imbibed as a nymph and transmitted by the adult. Doctor Theiler[15] also seems to have shown that spirillosis of cattle in South Africa is transmitted by *Margaropus decoloratus*. Koch has since found cases of this spirillosis in Daressalem, German East Africa, and has succeeded in tracing the spirochaetæ to within the eggs of the ticks.

To Doctors Marchoux and Salimbeni[16] belongs the credit of first demonstrating that a tick transmits a spirochaetæ. In 1903 they published a report of their studies, showing that the Fowl Tick, *Argas miniatus*, is an agent in the transmission of spirillosis in fowls at Rio Janeiro, Brazil. The disease seems to be transmissible by the innoculation of infectious blood. While the tick is one agent, the disease may also be transmitted by feeding blood or excrement of diseased fowls, thus it does not seem that the spirochaetæ is necessarily dependent biologically upon the tick. Balfour[17] has found what appears to be the same disease of fowls in the Soudan of Africa, and Reaney[18] that it is endemic in Central India.

Motas[19] has shown that *Rhipicephalus bursa* transmits carceag or ovine piroplasmosis in Europe. This tick passes the larval and nymphal stages upon the same animal, but drops to the ground for the second molt. The infection (as is the case of *Haemaphysalis leachi*) is transmitted by the adult, when the adult of the previous generation has fed upon an infectious host, and not by the larva or nymph.

Kossel[20] and associated investigators have demonstrated that piroplasmosis of cattle in Europe is transmitted by *Ixodes ricinus*. This tick drops for both molts, the larva and nymph being pathogenic. This is of importance, as it may be found to do the same in this country.

In 1905 Dutton and Todd[10] published an account of their study of the so-called human tick fever in Congo Free State. They found it to be produced by a spirochaetæ that has since been determined by

Breinl and Kinghorn[21] to be new to science and described as *Spirillum duttoni*. This spirochaetæ can be transmitted from animal to animal by the bite of the Tampan Tick, *Ornithodoros savignyi* var. *caecus* (=*moubata*). In the experiments of Dutton and Todd, rabbits, guinea pigs, rats and monkeys were used. The infection was found to pass through the egg. Koch[6] working independently in German East Africa in 1904 made the same discovery. He found the spirochaetæ to multiply within the egg and that the young ticks from infected localities are capable of infecting monkeys.

Skinner[22] states it his belief that the ticks common on rats in India transmit the plague bacillus.

The connection between ticks and Rocky Mountain spotted fever of man in this country has been the subject of considerable investigation. Dr. H. T. Ricketts[23] of Chicago and Dr. W. W. King[24] of the United States Public Health and Marine Hospital Service have succeeded in transmitting the disease from one guinea pig to another by the application of *Dermacentor occidentalis*. Later, Doctor Ricketts has produced the disease in a guinea pig through the attachment of 36 males which were collected partly from horses and cows and partly from the vegetation in the vicinity where the disease occurs. This seems to prove that the tick is the natural transmitter of the disease.

For some time it was thought that louping ill, a disease of sheep in Scotland, was transmitted by the European Castor Bean Tick, *Ixodes ricinus*, but Wheler[25] recently states that this apparently has been disproven.

Modder[26] states his belief that the yaws of paranghi disease of man and cattle in Ceylon, which is produced by a spirochaete, is transmitted by a tick. Bettencourt, Franca and Borges[27] have described from a deer in a park at Mafra, Portugal, a bacilliform plasma which they believe to be introduced into Europe by ticks from zebus in the park.

Laveran and Nègre[28] suggest the possible transmission of a disease in an African land turtle, due to a Haemagregarine, by the Bont Leg Tick (*Hyalomma aegyptium*.)

In this country Professor H. A. Morgan[29] has studied several species and has determined that neither *Dermacentor variabilis* nor *Amblyomma americanum* transmit splenetic or Texas fever. Dr. N. S. Mayo[30] has reached the same conclusion with the latter species.

Aside from splenetic or Texas fever and Rocky Mountain spotted fever, no disease in this country has been determined as transmitted by ticks, although it is suspected that spirillosis of fowls may occur and be thus transmitted in southwestern Texas. It has also been pointed out to the writer by Prof. H. A. Morgan that hunting dogs

taken from Louisiana to Cuba often sicken and die, possibly due to a disease transmitted by ticks.

That various parasites exist in the blood of animals, many of which are at present unknown, there can be no doubt, although the great activity along this line of investigation during the past few years has brought many to light.

The possibility that diseases which are transmitted through the agency of ticks may be introduced into this country must be considered. If such a disease as is suggested exists in Cuba, it might be introduced into this country with returning dogs. Prof. Lounsbury states that the malignant jaundice of dogs in South Africa and India has already been introduced into France and that it is likely to be introduced into this country. He states that should Angora goats be brought to this country from South Africa that they might bring heartwater which is so common on the veldts of that country. We trust, however, that the rigid inspection of animals entering this country by the U. S. Department of Agriculture, through the Bureau of Animal Industry, may prevent the introduction of such diseases.

While the scarcity of ticks in the colder sections might exclude the transmission of these diseases, yet in the warmer parts of our country, where the species and individual ticks are numerous, an intermediate tick host might readily adapt itself. It must be emphasized that the prevention of the importation of ticks is not sufficient. The danger is in animals, the blood of which is infectious, that may be attacked by native ticks.

The rapid development in our knowledge of the active agents in the transmission of diseases indicates the opportunities and possibilities that may result from a better knowledge of this group of parasites, and emphasizes the importance of a better acquaintance with the life history and habits of our North American ticks.

In this broad field of investigation it remains for the entomologist in this country to elucidate the biology of the ticks, as has been so ably done in South Africa by Lounsbury.

I have prepared the following table which shows graphically this relation of ticks to disease:

TABLE SHOWING THE RELATION OF TICKS TO DISEASE.

Disease: Name	Host	Geography	Due to	Tick concerned.	Infection: Imbibed by	Infection: Transmitted by	Molts: First	Molts: Second
Splenetic Fever, Texas Fever, Red Water or Bovine Piroplasmosis	Cattle	North America	*Piroplasma bigeminum*	*Margaropus annulatus* Say	adult?	larva	on host	on host
	"	Australia	" "	" *australis* Fuller	" ?	"	" "	" "
	"	South Africa	" "	" *decoloratus* Koch	" ?	"	" "	" "
	"	South America	" "	" *microplus* Canst.	" ?	"	" "	" "
	"	Europe	" "	*Ixodes ricinus* Linn.	adult	larva, nymph	off "	off "
African Coast Fever, Rhodesian Cattle Disease or East Coast Fever	"	South Africa	" *parvum*	*Rhipicephalus appendiculatus* Neum.	larva nymph	nymph adult	" "	" "
				" *simus* Koch	nymph	adult	" "	" "
				" *nitens* Neum.	larva	nymph	" "	" "
				" *evertsi* Neum.	nymph	adult	on "	" "
				" *capensis* Koch	nymph	adult	off "	" "
Malignant Jaundice	Dog	South Africa	" *canis*	*Haemaphysalis leachi* Aud.	adult	adult (2nd gen.)	" "	" "
		Madras, India	" "	*Rhipicephalus sanguineus* Latr.				
Biliary Fever	Horses Mules Donkeys	South Africa	" *equi*	*Rhipicephalus evertsi* Neum.	nymph	adult	on "	" "
Carceag or Ovine Piroplasmosis	Sheep	Southern Europe	" *ovis*	" *bursa* Can. and Frans.	adult	adult (2d gen.)	" "	" "
Heartwater	Sheep Goats Cattle	South Africa	Unknown	*Amblyomma hebraeum* Koch	larva larva nymph	adult nymph adult	off "	on "
Rocky Mountain Spotted Fever	Man	North America (United States)	"	*Dermacentor occidentalis* Neum.	larva nymph	nymph adult	" "	off "
Brazilian Septicaemia, Spirillosis	Fowls	South America Soudan, Africa	*Spirochaete gallinarum*	*Argas miniatus* Koch	....	....	" "	" "
Spirillosis	Cattle	Transvaal	*Spirochaete theileri*	*Margaropus decoloratus* Koch	....	....	on "	on "
Human Tick Fever	Man	Central Africa	" *duttoni*	*Ornithodoros savignyi* var *caecus* Neum. (*moubata*)	adult adult	adult larva	off "	off "

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The eighth annual meeting of the Louisiana Society of Naturalists was held at New Orleans, February 1st. This Society is well known to scientific workers, especially those engaged in research work in the strictly biological sciences, who are located in the Southern States. The Society has a membership of over seventy, many of the members being connected with agricultural experiment stations or with leading educational institutions of the South. The Society's field is a broad one and among its publications are found meritorious papers upon botany, bacteriology, ornithology, animal physiology and invertebrate zoölogy, as well as a considerable number of papers upon various entomological subjects.

On the program was noted the following papers which are of interest to economic entomologists: "Notes upon the Life History and Habits of the Argentine Ant."—Wilmon Newell. "A short account of the Egg and Larva of a Psychodid."—B. H. Guilbeau. "The Relation of Entomology to Agriculture."—Arthur H. Rosenfeld. "Notes on the sugar cane pou-a-pouche." —J. B. Garret.

Mr. B. H. Guilbeau of Baton Rouge is President and Mr. R. S. Cocks, of Baton Rouge, is Secretary of the Society.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN OF THE ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

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* The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Reprints of contributions may be obtained at cost. Minor line figures will be reproduced without charge, but the engraving of larger illustrations must be borne by contributors or the electrotypes supplied. The receipt of all papers will be acknowledged.—Eds.

The Journal, as the official organ of the Association of Economic Entomologists, will publish the proceedings of the annual meeting in the first two numbers. This matter alone will make the serial indispensable to every working entomologist and of great value to horticulturists, nurserymen, nursery inspectors and all others interested in the latest entomological developments along agricultural lines. Furthermore, it is expected to publish, in the later numbers, a large amount of original matter which would ordinarily be excluded from entomological bulletins, reports, systematic journals or other existing publications, as well as summaries of much of the best economic work. It will be by far the most comprehensive of existing publications along these lines and should appeal to a wide constituency. It is only necessary to mention such pests as the codling moth, the San José scale and urgent problems like the control of the boll weevil, the gypsy and brown-tail moths, the cattle tick and the recent discoveries respecting the role of insects in the dissemination of diseases, such as malaria, yellow fever, typhoid and other maladies dangerous to man and beast, to gain some idea of its scope. It is hoped that all of our three hundred economic entomologists at least will contribute freely of their best to these pages, that this journal may take a high position as a scientific publication, representing the most advanced thought in its chosen field, not only in this country but throughout the world.

The Journal is designed especially to serve the investigating entomologist, and all matter relating to new insect pests, variations in habit, method and form of injury, manner of control and biological observations (even on forms not of economic importance), will be heartily welcomed to these pages. Practical considerations render it necessary to debar articles having a preponderance of purely descriptive or systematic matter. This is hardly the place to publish original descriptions, though it is recognized that a certain amount of

descriptive matter is a necessity. The recent discoveries relative to insects and diseases have resulted in ranking previously almost ignored groups among those of prime economic importance, and have opened up new and widely divergent fields for investigators. The importation of parasites upon a large scale, as in the gypsy moth work, is another relatively new and very promising field. Other important discoveries are yet to be made. The recently available Adams fund has made it possible for our experiment stations to devote considerable sums of money to work of the highest character, and it is not too much to expect that the next decade may witness most striking advances. THE JOURNAL is world-wide in circulation and interest, and the stimulus resulting therefrom will be most beneficial.

The discussion of methods should have an important place in this JOURNAL, since it is impossible to secure accurate results unless the standards of judgment be correct. Students of such pests as the codling moth have learned to their sorrow the difficulty of attempting to correlate observations made under widely different conditions. Much can be learned by coöperative work and full value from such effort can be realized only after there has been a practical agreement as to methods. The establishment of standard tests and methods of observation receiving wide acceptance, would result in untold benefit to future workers. The discussion of methods employed in other lines of investigation and their adaptation to our conditions should also prove most fruitful. It is planned to have a department devoted to technique and methods, and provision has already been made for a department of current notes, which latter is in charge of the associate editor. Dr. Howard, through his bureau, has consented to prepare summaries or reviews of the more important foreign publications on economic entomology, and critical reviews of notable contributions may be expected from time to time.

The Chicago meeting of the Association of Economic Entomolgists was one of the most successful in the history of the organization. The attendance was very nearly as large as at the recent New York meeting, while the crowded program made necessary a supplementary session on Saturday evening. The papers were of exceptionally high character. The grouping of subjects assisted very materially in getting through the program expeditiously and at the same time allowed at least a moderate amount of discussion. It was the sense of the members present that in the future it might be well to limit most papers to fifteen minutes or thereabouts, so as to allow more time for discussion. Now that we have means for prompt publication, there should be little objection to the presentation of summaries,

leaving the details for the published proceedings. This will do very much toward relieving the congestion of the program. Perhaps the most important step taken at this meeting was the organization of a stock company for publishing THE JOURNAL OF ECONOMIC ENTOMOLOGY, a serial which is bound to have a most profound influence on the development of economic work, provided it receives the hearty support of entomologists throughout the country. The American Association of Horticultural Inspectors held a session the evening of December 27th and were in a joint session with the entomologists the morning of the 28th. A summarized report of the proceedings of the Horticultural Inspectors may be expected in a subsequent issue.

Reviews

Mosquito Life, by EVELYN GROESBEECK MITCHELL. G. P. Putnam Sons, 1907, p. XXII+281, illustrated.

This popular comprehensive work on mosquitoes is an exceedingly valuable addition to the library of any one interested in this important group, since it not only gives an excellent summary of the voluminous literature relating to this subject, but contains numerous original observations by the late Dr. Dupree and the author. It is particularly valuable because of the relatively full account of southern forms and the intimate knowledge displayed of conditions obtaining in that section of the country. The general structure and habits of mosquitoes are rather fully discussed, the early stages receiving unusually extended treatment. The chapters on malaria and yellow fever are excellent summaries of our knowledge in regard thereto. Brief biological notes are given on the more common species, they being grouped under the following heads: Mosquitoes known to spread disease, the salt marsh mosquitoes, other swamp forms, the domesticated mosquitoes, breeders in streams and ponds and the woodland breeders. The portions relating to eggs and pupæ are practically all new. Original keys are given for the first time for the separation of a number of species in all stages, those based on the egg and pupa being unique. The keys of both larvæ and adults are based largely upon the most obvious features and will be exceedingly useful to the amateur as well as serviceable to the advanced student. A systematic list of North American species is given, followed by a list of the more important works on Culicidæ. These latter form an excellent introduction to more extended investigations. There is also an appendix on mosquitoes and leprosy. The author is to be congratulated upon having produced a popular and comprehensive summary of our present knowledge concerning mosquitoes. This work will prove of great service to young students, particularly those in the Southern states, and on account of the original information contained therein, is indispensable to the advanced investigator.

Current Notes

CONDUCTED BY THE ASSOCIATE EDITOR

A new elective course on "Insects and Disease" is being given by Prof. V. L. Kellogg, in the Department of Entomology of Leland Stanford University. It is open to students who have had some previous work in biology and consists of one lecture and one laboratory period, of three hours, a week. Forty students are now taking this course, most of them being upper classmen who have selected majors in physiology, zoölogy or entomology.

The lectures cover the etiology of the insect-disseminated diseases, the relations between the insects and the disease germs and the methods of fighting and controlling the insects. The laboratory work covers the structure and life history of the insects and the determination of disease parasites.

Mr. A. A. Girault, who for several years has been engaged in the investigation of insects injurious to fruit for the Bureau of Entomology, has resigned and accepted a position with Dr. S. A. Forbes, State Entomologist of Illinois.

Mr. H. L. Viereck has accepted a position with Prof. H. A. Surface, State Zoölogist of Pennsylvania, and will take charge of the insect laboratory. Address, Capitol Building, Harrisburg, Pa.

Mr. G. P. Weldon has resigned as Assistant Entomologist to the Maryland Agricultural Experiment Station, to accept the position of Assistant Entomologist in Colorado, and will have charge of the western slope fruit investigations. He enters upon his new duties February 15. Address, Grand Junction, Colo.

The next issue of Wytsman's Genera Insectorum, to be published in March, comprises a catalogue of the Mallophaga of the world by Prof. V. L. Kellogg of Stanford University, California. Twelve hundred and fifty-seven species are recorded, fifty-two of which occur on mammals and the remainder on birds. About one fourth of the total number have been found on North American hosts. The catalogue gives all recorded host species and geographical distribution of each species.

Mr. D. K. McMillan has resigned his position as assistant to the State Zoölogist of Pennsylvania, Prof. H. A. Surface, and accepted a position with the Bureau of Entomology. He is now engaged in investigating truck crop insects at Brownsville, Texas.

Mr. R. L. Webster, who has just completed his studies in entomology at the University of Illinois, has accepted a position under Prof. H. E. Summers, State Entomologist of Iowa. Address, Ames, Iowa.

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Proceedings of the Twentieth Annual Meeting of the Association of Economic Entomologists

(Continued from February number)

A paper was next presented by Mr. Forbes:

EXPERIMENTS WITH REPELLENTS AGAINST THE CORN ROOT-APHIS

By S. A. FORBES, *Urbana, Ill.*

(Abstract.)

In consequence of reports from farmers of beneficial results of the use of kerosene on seed-corn, a strip through a large field was planted, in 1905, with seed which had been soaked in kerosene, and as a result a considerable percentage of the seed was damaged, though the plants were protected for some weeks against injury by the corn root-aphis. On the supposition that the latter effect was due to the odor, experiments were made during the winter of 1905–06 with carbolic acid, oil of lemon, formalin, minimum quantities of kerosene, and a variety of other volatile oils and odoriferous substances, from which the four above mentioned were selected for trial in the field. The kerosene was used at the rate of a teaspoonful to a gallon of corn, thoroughly stirred in just before planting, the oil of lemon as a 10% solution in alcohol, and the carbolic acid and the formalin as 3% solutions in water. Three ounces each to a gallon of corn were used of the oil of lemon mixture and the carbolic acid solution, and six ounces to the gallon of the solution of formalin.

Strips of twelve to twenty-four rows each and eighty rods in length were planted with treated seed, intervening strips being left as

checks. The weather of the spring was dryer than usual, but not sufficiently so to delay noticeably the sprouting of the seed or the growth of the plants. A preliminary examination of the field showed an average of 512 colonies of *Lasius americanus* to each acre, equivalent to 1,840,000 adult and larval ants.

Six weeks after planting, hills were dug up freely in both check and experimental strips, and all the ants and aphids were counted in each case, with the general result that the strip planted with seed which had been treated with carbolic acid showed a reduction of 14% in number of aphids per hundred hills of corn, and 17% in number of ants; that treated with formalin showed a reduction of 60% in number of aphids and 48% in number of ants; the kerosene strip, a reduction of 84% in aphids and 58% in ants; and the strip planted with seed treated with the oil of lemon, a reduction of 89% in aphids and 79% in number of ants. The reduction in number of hills infested at this time was as follows: Carbolic acid, 15%; formalin, 44%; kerosene, 47%; oil of lemon, 58%. At the end of ten weeks the average height of stalks in the central row of a check strip—measuring only the highest stalk in a hill as it stood, without stretching it up—was 35 inches. The corresponding average of stalks in an experimental strip was 60 inches. On September 21, nineteen weeks after planting, a check row contained 330 hills with corn; a row from the oil of lemon strip, 326; a row from the kerosene strip, 282—a loss of 48 hills, due doubtless to the effect of the kerosene on the seed. The stalks at this time were 620 per row in the check, 641 in the plot treated with oil of lemon, and 510 in that treated with kerosene—a gain of 21 stalks, apparently due to the lemon treatment, and a loss of 110, due to the kerosene treatment. Ears at this time averaged 413 per hundred hills for the check strip, 526 to the hundred for the lemon strip, and 455 per hundred for the kerosene—a gain, from the use of lemon, of 113 ears and from the use of kerosene, of 42. The gain in number of ears was thus practically 20% where oil of lemon was used. There was also a notable difference in the size of the stalks and the ears in all the experimental strips as compared with the checks.

Similar and more extensive experiments made with a variety of more or less promising substances during the spring of 1907 were virtually without result, owing to heavy and repeated rains during the planting season and for some time subsequent, the effect of which was to remove all traces of the repellent substances from the planted seed and at the same time to suppress almost completely the corn root-aphis in the field. Trial plantings, made by farmers in various parts of the state, of seed-corn treated with oil of lemon, have in some cases re-

sulted in noticeable injury to the seed, showing that this substance as sold is of very unequal quality and apparently of unlike composition.

In reply to questions Mr. Forbes stated that the rows of corn in the field were about a quarter of a mile long; that the seed corn had been specially selected for the purpose and that, in the strips where the lemon oil was used, at a cost of about ten cents per acre, the ants were present between the rows, but very few aphids could be found.

Mr. Bishopp stated that he had tried repellants against the cotton boll weevil, including lemon, cinnamon, tar and clove oil. The odor of the latter was most persistent, but where it was used the plants showed greatest injury.

Mr. Forbes remarked that when lemon oil was introduced into artificial ants' nests it seemed to set them crazy, as they acted in a very confused and abnormal manner, even neglecting and deserting their young.

Mr. Taylor presented a paper:

LIFE HISTORY NOTES AND CONTROL OF THE GREEN PEACH APHIS, MYZUS PERSICAE

By E. P. Taylor, *Mountain Grove, Mo.*

The aim of this paper is to add a few new observations upon a very old insect. It was in 1761, nearly a century and a half ago, that Sulzer first described this pest in Europe. It has been mentioned in most works upon the Aphididæ as well as in treatises upon general entomology published in this country for many years, and has long since been included in the lists of insects injurious to the peach in the United States and Canada. Like many of our common insect enemies, however, there have been and are yet many points concerning it unrecorded.

During the past two years or more this insect has become in parts of the country a pest of more than passing importance. The peach growers of Western Colorado have suffered loss from it; from its heavy infestation of the leaves of the trees in the spring, causing them to curl and drop prematurely to the ground, and from the withering and subsequent dropping of the buds and forming peaches also infested by the aphides at this time. It is probable that in many parts of the country this plant louse has not yet appeared in such injurious numbers as to infest and destroy a portion of the crop itself as it has in Western Colorado, but the insect is of interest since it is known to

occur in nearly all portions of the United States where peaches are grown.

Our interest is also increased when we realize to what extent it has probably been confused with other species of the sub-family Aphididæ, and when we understand the factors which have led to this confusion.

My first notice of the insect as an economic pest in Colorado was at Grand Junction on April 13th, 1906, and brief mention was made of it in Bulletin No. 119, Colorado Agricultural Experiment Station. Its identity was then unknown to me and before undertaking any control experiments material was sent to Prof. C. P. Gillette, our best authority on the Aphididæ of that section. Samples of the material were also sent to Mr. Theo. Pergande of the United States Department of Agriculture, who gave to the insect the name *Rhopalosiphum dianthi* Schrank, as did Professor Gillette on first looking over the material. The latter, after further study of the insect and literature, concluded that the name *Myzus persicae* Sulzer should be applied to it. In this study of it certain matters of importance regarding the synonomy of the insect were brought out and I shall quote from a letter of Professor Gillette dated November 7th, 1907: "Let me change my opinion in regard to what this louse ought to be called. I decided to call it *diantha* Koch, but our species seems to be the *persicae* described by Sulzer in 1761 and which is described and figured by Buckton in his work on British Aphididæ, vol. 1, page 173. Buckton's figures correspond remarkably well with the louse that we have been working on here. I also believe that *Rhopalosiphum solani* Thomas, *R. dianthi* Schrank, and *Myzus achyrantes* Monell are synonyms of this species. All of the returned migrants that we have found upon plum, peach and cherry during the fall have had cornicles that were slightly swollen or clavate in form. The first winged forms in the spring that appear on these same trees seem exactly like the fall winged form, except that the cornicles are not at all swollen. I was greatly puzzled over this fact last spring and determined to watch very closely this fall to determine whether or not the form with swollen cornicles would again appear upon the peach and plum trees. For the past six weeks these migrants with swollen cornicles have been gathering upon these trees and depositing the oviparous form which becomes pink or salmon in color as it grows toward maturity. Since the middle of July we have been taking this louse upon a large variety of plants and in all cases we have found the cornicles swollen. This seems to account for the louse being called a *Rhopalosiphum* when described from the summer and fall form and *Myzus* when described from the early spring form before it leaves the peach, plum and cherry

tree. The specimens you sent April 30 and May 7 from peach all have cornicles cylindrical. The fall migrants and the specimens sent from tomato and turnips early in the summer all have clavate cornicles in the winged form. * * * The distinguishing character of this species for the winged individuals seem to be: Antenna longer than the body upon pronounced frontal tubercles which are quite approximate, second joint of antenna moderately gibbus, third joint with sensoria on the ventral side only and a large dark patch upon the dorsum of the abdomen anterior to the cornicles, and during the late part of the season the cornicle moderately clavate in the winged forms."

A point brought out by the foregoing is that the large per cent. of the descriptions of this and related species were made from specimens taken in the fall. I have recently had an opportunity to go over with Mr. J. T. Monell of St. Louis some accession records of collections of this species made during a period of about thirty years and the majority were found to have been made in the fall. In fact but a single exception to this was found, which was in the case of the species given by Mr. Pergande as *Aphis persicae* Sulz., and taken by him in St. Louis in May, 1879.

I have found in Western Colorado the eggs or stem-mothers of *Myzus persicae* Sulz. upon peach and plum and the lice have been found in that state at different times upon peach, nectarine, plum, prune, cherry, choke-cherry, sand-cherry and more rarely upon pear, apple, crab-apple, willow and cultivated rose. Also the following herbaceous plants have been found as host plants at some seasons of the year: Turnip, rape, cabbage, tomato, potato, false-mallow (*Malvastrum* sp.) yellow-dock, red-root (*Amarantus* sp.) mustard, shepherd's-purse, snap-dragon, carnation, rhubarb and egg-plant. In not every instance upon the plants given were the pink or salmon-colored lice present, although the collections were sometimes made in the spring or fall when this form would have been expected. This leaves perhaps a possibility of other species being mistaken for this one unless the kind of food plant had affected the coloration of the louse. Mr. Monell recently showed me two samples of what seemed to be this species taken by him November 2–4, 1907, at Shaw's Garden, St. Louis, one from cabbage and one from peach. Both cases showed the winged forms with slightly dilate cornicles and otherwise appearing the same, but none of the lice upon the cabbage showed the salmon color, though they were abundant upon the peach leaves at that time.

In this paper I have designated this insect as the green peach-aphis, to distinguish it from the black peach-aphis, with which it is sometimes confused. It is very different from the latter, however, which has in

the matured insects a shining black body and young of a reddish-brown. The latter, too, is known to sometimes infest the roots of the peach, while the green peach-aphis, so far as is known, occurs only above the ground.

If very abundant, the lice will be seen collecting thickly about the buds long before they open. If fewer in number, they may escape observation until the leaves are attacked and curled. In the spring of 1906 the writer noticed the serious bud infestation first on April 13. In 1907, eggs were found hatching at Grand Junction as early as February 16, owing to the unusually open winter and early spring. The eggs, small, oval and shining black, resemble very much the eggs of the green apple-aphis. They are deposited in the fall upon the twigs of peach or sometimes the plum or cherry and are tucked away under the bud or upon rough places along the bark, usually somewhere near the tips of the twig. They are not placed in such masses as the eggs of the green apple-aphis and it usually requires rather close searching to discover them. I found them deposited this fall as early as October 24 at St. Louis, and Professor Gillette reported them being laid freely at Ft. Collins, Colorado, as early as November 5.

Soon after hatching the lice crawl to some nearby leaf or fruit bud and insert their beaks into the more tender portion. At the time the first lice are hatched, the buds, though considerably swollen, are still protected by thick bud-scales which are more tender near the apex. The stem-mothers, when first hatched, are of a dark green color, with almost black appendages, and in length not more than 2-100 of an inch. As the inner and redder bud-scales are pushed out, these also become covered with stem-mothers, which after their first moulting of skins begin to assume shades of pink or salmon. These shades will be first noticed along the lateral margins of the body. As the stem-mother increases in size and continues to moult, this color becomes more prominent. Examined carefully, these dorsal abdominal markings will be found to consist of light terra-cotta or even maroon colors upon an apple green, the combination giving a salmon or pink in general effect. All stem-mothers do not take on this typical shade, but remain green throughout their lives and those which do assume the salmon color often fade back into almost a green toward the close of the period of their existence.

The stem-mothers blend very closely with the colors of the buds and blossoms and are therefore not easily seen. At the time of the birth of their first young, they measure about 8-100 of an inch in length. The young, which are born living, are at first much paler green in color than were the stem-mothers when first hatched. The apterous in-

dividuals of all generations appearing after the spring stem-mother remain greenish in color throughout the season up to when the sexual females are found upon the leaves in the fall. These deposit the overwintering eggs and the lice are also of a salmon or pink shade, very much like the stem-mothers of the spring.

I have counted as many as a score of the stem-mothers in the spring clustered over the surface of a single unopen bud. When the buds break into bloom, these stem-mothers and their progeny crowd within, attacking petals and inner walls of the corolla as well as the stamens, style and ovary. The bloom is distorted, becomes withered and finally falls. In other cases the clusters of lice form later about the peaches, when about the size of peas, and by sucking away the sap cause them to also fall from the trees. About this time the lice will also begin to infest the leaves, curling them tightly, by infesting their under surfaces, and when severely attacked all parts of the leaf-blade will be completely covered. After the second molt of the stem-mothers, minute drops of honey-dew may be seen to form at the tip of the insects's body and be thrown away with a quick movement. This honey-dew may appear before the buds open as moist, sticky areas upon the twig above the louse. Later in the spring, the leaves in badly infested terminal clusters become completely coated with this secretion and attract numbers of ants, flies and other insects.

The infested leaves become thickened and pitted from beneath, turning red in spots and finally falling away. About the middle of May, 1907, many peach trees in Western Colorado were almost completely stripped of their foliage and it was feared by many growers that some would never revive.

Winged lice developed among individuals of the first generation following the spring stem-mothers and were seen in the orchards as early as April 13, 1907. They appeared as a rule first upon leaves greatly over-crowded by the wingless lice and soon after developing wings, spread to other leaves and trees to start new colonies. The proportion of winged ones increased as the season advanced. About the middle of May last year at Grand Junction, when the leaves of the trees had become heavily infested, not only winged but the wingless lice were seen to commence migration in great numbers from peach trees. By the last of May or the first days of June, scarcely a single one could be found upon them. It was indeed interesting to witness this phenomenal dispersion of plant lice. Each seemed anxious to forsake the peach leaves before its neighbor. Some days the air in badly infested peach orchards would be filled with flying aphides. The ground in such orchards would be thickly scattered with crawling,

wingless aphides. In one instance, trunk-bands of the sticky substance known as "Tree Tanglefoot" had been placed upon apple trees in order to catch the crawling woolly aphides. These apple trees were adjoining an orchard of peach and when the crawling lice from the peaches started up the trunks of the apple they were caught in such numbers that the lower borders of the bands were green with a mass of their bodies. The peach trees, now deserted by their parasites, the aphides, soon began to form new leaves and within a few weeks were once more in heavy foliage. The wingless migrating aphides evidently perished in great numbers upon the ground before reaching other food plants; some winged ones safely reached other plants at a distance, where they established new colonies and multiplied until the winged migrants returned again to the peach in the fall.

Life history records for the early spring generations were secured in the breeding cages. Stem-mothers were kept alive from twenty-three to twenty-nine days from hatching. About eight days passed from hatching to the first molt, four or five days from the first to the second molt and about the same time from the second to the third. From fifteen to seventeen days were passed by the stem-mother from hatching to the birth of the first young. This record was secured by confining single stem-mothers in cages alone, and thus demonstrating them to be parthenogenetic. The first young were born about the time of the third molting by the stem-mother. The maximum number of young secured from one stem-mother in the cages was twenty-six.

The first young of the second generation from the eggs were seen born in the orchard at Palisade on March 14, 1907, though some were secured in cages as early as March 4. From the birth of the second generation to the first molt was from four to five days and from their birth to their becoming equipped with wings was on an average of from eleven to sixteen days. This second generation usually bore the first of the third generation about twelve to seventeen days from their birth and at about the time the first winged lice appeared. Only a portion of the second generation of lice developed wings. From twenty-eight to thirty-three days seemed about the length of life from birth to death of a second generation individual.

The third generation of agamic aphides were found in the orchard at Grand Junction last season on March 24. These lice are a trifle smaller at birth than the generation born by the stem-mothers. It will be seen that as many as thirteen generations of the green peach aphis may be produced through a single season if the same rate of development is kept up through the summer to the time when eggs are again deposited in the fall.

The food plants which carry the species through its summer generation appear to be of great variety, as shown by the list already mentioned. So few lice are to be found, however, upon these plants during the summer in comparison with the countless numbers which are produced in the peach orchards in the spring that it seems very probable that other plants will also be found harboring it through the summer months.

In the Grand Valley peach orchards the first returning migrants were noticed about the middle of September, when I found them collecting upon the dorsal side of the leaves, principally along the midrib and veins, though they were not altogether restricted to these points. No early examinations of peach orchards were made in Missouri this fall, but on October 24, oviparous females were found depositing their eggs along the Mississippi and under date of November 5 Professor Gillette wrote me from Colorado that the eggs were being deposited upon peach, plum and cherry, though many of the winged and wingless viviparous females were still living upon many outdoor plants that had not entirely lost their foliage. The male insects are winged and appear in Colorado from about the middle of September to when they are killed by the cold nights. In Missouri, near St. Louis many eggs were still being freshly deposited in peach orchards as late as November 16.

Parasites and predaceous enemies rendered the orchardists of western Colorado much service in destroying great numbers of these insects last summer. Among these were the larvae of syrphus flies and lace-wings, and the larvae and adults of lady beetles. A small hymenopterous parasite was seen to infest the lice and a Thomisid spider identified by Mr. Banks as *Thisumena lepida* Thorell was observed to be of service. Sparrows, canaries, orioles and other birds were also of economic value.

Experiments by the writer towards the control of this pest were undertaken against it only so far as it affected the peach. In the commercial orchards of Western Colorado its only injury has been caused to this fruit.

The remarkable power peach trees have of reviving after being almost completely defoliated by these lice makes the insect somewhat less formidable. However trees so completely stripped of their foliage and devitalized as they are in some cases are retarded in both the development of the tree and fruit. From a practical standpoint the destruction of the lice which may infest the fruit buds, blossoms or newly formed peaches may be considered of the greatest consequence to the grower.

We find insecticides recommended against this insect in the works of Dr. Cyrus Thomas, formerly state entomologist of Illinois, and published in the transactions of the Illinois State Horticultural Society for 1876. Townsend observed the insect in New Mexico upon peaches and recommended contact sprays against it in Bulletin No. 3, New Mexico Agricultural Experiment Station, June, 1891. Saunders, Weed and many others have also suggested treatments. Washes of strong soap-suds, tobacco-water, kerosene emulsion and many other contact insecticides commonly used against sucking insects were advised.

From the experience of the writer, it has seemed that time and manner of application has had much to do with successful results. I have conducted experimental spraying against this insect near St. Louis, Missouri, in a peach orchard of about one hundred and thirty medium aged trees, the spraying being done on November 16. In Colorado a commercial peach orchard at Palisade was carefully selected and treated on March 16, 1907, when the stem-mothers were thickly covering the outside of the peach bud. The peach buds were swollen and ready to burst into bloom. The first new-born of the second generation were appearing, but neither these tiny green lice nor the larger pink-bodied stem-mothers had gained entrance into the blossoms beyond the reach of contact sprays. At that date practically all of the eggs had been hatched.

An orchard of about one hundred peach trees at Grand Junction was chosen in which no spraying was given up to April 16, when portions were given a thorough treatment with different contact sprays. At the time this spraying was done, the leaves of the trees were badly infested and the lice concealed to a large extent within the folds.

In both of the orchards a thorough spraying was given, but it was plainly apparent that the orchard first mentioned—the one sprayed late in the spring, but immediately preceding the opening of the buds—was the one in which the better results were secured. In the one sprayed after the leaves had become curled, it was found almost impossible to reach the bodies of the lice. Some of course were killed when a strong stream of spray was forced into the branches under a high pressure, but it was manifestly too late to expect the best results.

Among the most promising insecticides used in the experiments and by orchardists who sprayed last spring for this pest in Colorado were kerosene emulsion, containing 5% oil, Scalecide diluted 1 part to 20 parts cold water, tobacco decoction made by steeping for an hour 1 pound of leaf tobacco or 2 pounds strong tobacco dust or stems in

4 gallons of water. "The Black Leaf Extract of Tobacco" proved equally successful when used at the rate of 1 gallon to 65 gallons of cold water.

If the kerosene emulsion or other commercial oil emulsions are used, it should be with the usual precautions. Complete emulsification and known percentage of oil are essential. The above strengths of emulsion gave no injury used in the manner described. No practical benefit was secured, so far as the green peach aphis is concerned, from the use of orchard-boiled or commercial lime-sulphur washes, applied late in the spring just before the buds open. All spring prunings of the peach twigs should be gathered up and burned to prevent the aphis eggs harbored upon them from hatching and the lice crawling back upon the tree.

[Mr. Headlee's paper on *Diabrotica vittata*, together with the discussion thereupon, has been held till the next issue, owing to delay in submitting the manuscript.—E. P. F.]

The following paper was presented:

A KEY SUGGESTED FOR THE CLASSIFICATION OF ENTOMOLOGICAL RECORDS

By W. E. Hinds and F. C. Bishopp.

Object and application of key. This key is designed to facilitate the arrangement of entomological notes, materials, etc. It is not to be used as are guide cards, but all cards belonging in the key are *placed together in front of the note file* to show the general plan of arrangement of the notes which follow. Thus *one key* serves for the entire note system and no repetition is needed for the various species regarding which notes are made.

It is not at all necessary that all notes to be classified according to this key should be prepared in any particular form or kept together in one place. In fact, the key may be applied almost equally well to any notes except those in bound books. No argument is needed as to the many advantages of the modern card system over the old bound note book system. The size of cards to be used is a matter for personal choice and the only argument for uniformity is that of convenience in filing and handling the notes. In the Cotton Boll Weevil investigation a four by six inch card was found to be most convenient for field notes and therefore adopted for practically all records of the investigation. The cards were prepared by the printer in the

form of board covered books of fifty sheets each. The leaves were perforated to form the cards as they were removed from the binder.

Notes of any unusual size may be conveniently placed in the file by enclosing them in a manilla envelope of exactly the size of the standard card adopted. Envelope and note are headed alike to insure their identification. Old loose notes may be thus brought into the file with modern cards.

As a matter of convenience we have found it best to place the key on cards. On a card placed in front of the key proper should be given an alphabetical list of the ordinal names adopted or to be followed by the user of the note system. The notes on each order of insects then follow in the sequence indicated on the first card. Under each order the notes are arranged alphabetically by generic names and the species alphabetically under each genus. The notes on a single species are thus brought immediately together under the scientific name of the species. If the common name is more familiar, a cross reference can be made from an alphabetical list of common names. Thus far the arrangement is purely alphabetical, but beyond this point the necessity for some definite method of arrangement arises to enable anyone to find desired notes among a large amount of data and to make the file accessible to and usable by any other than the original maker or filer of the notes.

The key indicates the topical headings to be used and the arrangement to be followed in filing the notes on each and every species alike. It is no longer possible to follow an alphabetical plan and the decimal system used in the Dewey system of library cataloging and in the great work of the Concillium Bibliographicum has therefore been adopted in its principal features. Under each species name, the notes are filed strictly according to the decimal sequence of numbering, except in a few cases where subdivisions can be better arranged alphabetically. In the key a certain decimal number is given to each topic or subject heading, into which the study of the insect may be subdivided and this same subject and decimal number should always be given as the heading on the note to be filed. The statement of both number and subject prevents errors and the misplacement of notes.

Miscellaneous notes or those on undetermined species may be filed temporarily under their accessions number.

The first part of the key applies to general things which assist in systematizing one's work and related records.

Heading of notes. Every note or card should deal preferably with one subject only. The card is given appropriate heading and in de-

termining this the key is almost indispensable. The upper left-hand corner is always reserved for the decimal number associated with the proper subject. The scientific name of the species considered appears at the top and middle of the card. Below the species name is given the subject heading, locality, date, etc. The author's name should also appear on each note.

The decimal numbering may be conveniently done by a specially constructed rubber stamp made after the manner of the ordinary band dating stamps. This special stamp should have at least six bands, each bearing in vertical line the following fifteen characters as separated by dashes: 1—2—3—4—5—6—7—8—9—0—.—,—:—(—) Space cannot be taken here for a discussion of the proper use of the comma, colon and parentheses. It is the same as in the Dewey System.

The use of guide cards. In the key itself, guide cards are used for indicating only the primary divisions: Generalia, Work, Life History, etc. It is well to list on the guide card the next series of subdivisional headings occurring under it.

Among the notes to be filed, guide cards should, of course, be used for each species and headed with the names of the order, genus and species. Beyond this the use of guides is purely a matter of personal convenience and the filer may decide for himself whether he cares to give any special significance to the color of card, size of tabs, etc. The guides in no way alter or interfere with the application of the key.

Cross-references. If the subject matter on a card relates to more than one insect, a cross reference card is made and filed under the name of the other species, in the proper decimal sequence of the subject. Similarly, a cross reference is made if the record relates to more than one topic in the study of one species or if the data may have application to more than one topic.

Amplification of key. Throughout the key there is ample room for further development as may be required to adapt it more fully to the study of any new subject and insertions may be made as they are found to be needed. It will be noted that in the series of main divisional numbers, 8 and 9 are unoccupied. In these cases, as in similar ones throughout the key, wherever numbers have been omitted or are unoccupied, there is room for additional subjects of properly co-ordinated character. Changes may be made to suit the user, either in the wording or character of a subject heading to fit any special need, but if there be room for addition of the needed subjects, it would seem better to add than to substitute. In this way the key is rendered more complete and generally applicable. Inappropriate head-

ings are simply unused, but remain in the key for the suggestive value they have and for use under species to which they do apply.

Practical usefulness of key. A fairly complete outline of this sort is valuable for its continual suggestion when undertaking the thorough study of any species. With any large volume of notes, particularly relating to one species, some system is indispensable. The key given herewith has been put to thorough test in the large amount of note material accumulated by the numerous agents of the Bureau of Entomology during the six years of the Cotton Boll Weevil investigation. Because of its proven value in this work, it is presented here as a suggestion of the possible divisions in the study of an economic entomological subject and as a practicable means of so arranging the records as to make them at all times easily accessible and completely useful and also because the system seems to be of general applicability in economic entomology.

Key to Classification of Entomological Records

O Generalia.

01 Bibliography.
- 01.1 Indices and references.
- 01.2 Special literature.
- 01.3 State laws affecting entomology.
  - 01.31 Quarantine regulations.
  - 01.32 Inspection of nursery stock.
- 01.8 Literature to secure.
- 01.9 Miscellaneous literature.

02 Statistical data.
- 02.1 Climatological. (See 44 also.)
- 02.2 Geological.
- 02.3 Crop reports.
- 02.4 Special census reports.
- 02.5 Special crop statistics.

03 Clippings.
- 03.1 Entomological workers.
- 03.2 Insect life histories. (See 71 for arrangement.)
- 03.3 Insect seasonal histories. (See 71 for arrangement.)
- 03.4 Insect control, natural.
  - 03.41 Climatological.
  - 03.42 Parasites.
  - 03.43 Predatory enemies.
  - 03.44 Diseases.
- 03.5 Insect control, artificial.
  - 03.51 Traps.
  - 03.52 Insecticides.
    - 03.521. Stomach poisons. (Arrange alphabetically.)
    - 03.522 Contact insecticides.
    - 03.523 Fumigants.
  - 03.53 Repellents.

O Generalia, *Continued.*

03 Clippings.
  - 03.54 Machines.
  - 03.55 Treatment of crop after harvesting.
  - 03.56 Restriction of spread.
  - 03.57 Cultural control.
- 03.6 Distribution.
  - 03.61 Geographical.
  - 03.62 Geological.

04 Accounts.
- 04.1 Appropriations.
- 04.2 Salaries.
- 04.3 Equipment.
  - 04.31 Furniture and fixtures.
  - 04.32 Scientific apparatus.
  - 04.33 Tools and machinery.
  - 04.34 Library.
  - 04.35 Live stock.
- 04.4 Maintenance.
  - 04.41 Supplies.
  - 04.42 Repairs.
- 04.5 Postage, stationery, etc.
  - 04.51 Postage account.
  - 04.52 Stationery accounts.
  - 04.53 Telegraph accounts.
  - 04.54 Telephone accounts.
- 04.6 Travel.
- 04.7 Freight and express.
- 04.9 Contingent expenses.

05 Species lists.
- 05.1 Economic insects.
- 05.2 Insects reported during correspondence.

O Generalia, *Continued.*

06 Host lists.
06.1 Animal hosts.
06.2 Plant hosts.

07 Documents.
08 Correspondence.
08.1 Special mailing lists.

09 Miscellaneous.
09.1 Inventory.
09.2 Common name directory of insects.

1 Work.

10 Work projected.
10.1 Outlines prepared for projects.
10.2 Forms for tabular records.

11 Work on hand.
12 Questions.
13 Instructions.
13.1 Forms for uniform note records.

14 Reports of species, occurrence to be investigated.
15 Methods and apparatus.
18 Illustrations.
18.1 Photography.
18.11 Formulae, tables and method notes.
18.12 Negative catalog. (Arrange alphabetically by subject, referring to consecutive numbers assigned to negatives.)
18.2 Drawings.
18.21 Record of sketches.
18.3 Cuts.
18.31 Catalog of cuts. (Arrange alphabetically by subject, referring to consecutive numbers assigned to cuts and to where cuts have been used.)

19 Reports of completed work.
19.1 Periodical reports of agents.
19.2 Publications listed.

2 Life History.

21 Egg.
21.1 Description.
21.2 Embryology.
21.5 Duration of stage.
21.6 Hatching.

22 Larva.
22.1 Description.
22.2 Anatomy.
22.21 External.
22.22 Internal.

2 Life History, *Continued.*

22 Larva.
22.3 Growth.
22.4 Molts.
22.41 Process of molting.
22.42 Effect of food supply upon number of molts.
22.43 Size between molts.
22.5 Duration of stage.
22.6 Pupation.
22.61 Pupal cells.

23 Pupa.
23.1 Description.
23.2 Anatomy.
23.5 Duration of stage.
23.6 Transformation.

24 Adult.
24.1 Description.
24.2 Period from transformation to emergence.
24.21 Changes before emergence.
24.3 Emergence.
24.31 Changes after emergence.
24.4 Size of adults.
24.41 Dimensions.
24.42 Weights.
24.43 Relation of size to food supply.
24.5 Duration of life.
24.51 Upon buds alone.
24.52 Upon seed pods alone.
24.53 Upon foliage alone.
24.54 Upon sweetened water.
24.55 Without food but with water.
24.56 Without food or water.
24.57 Average length of life, natural condition.
24.58 Hibernated adults without food.
24.6 Sexes.
24.61 Secondary sexual characters.
24.62 Relation of size and color to sex.
24.63 Proportion of sexes.
24.631 In spring.
24.632 In mid-summer.
24.633 In autumn.
24.634 During hibernation.
24.635. Among migrating adults.
24.64 Temperature influence upon sex determination.
24.7 External anatomy.
24.8 Internal anatomy.
24.9 Physiology.

25 Development.
25.1 Number of generations. (Localities arranged alphabetically by state and town.)
25.11 Minimum number in season.

2 Life History, *Continued*.

25 Development.

25.12 Maximum number in season.
25.13 Average number in season.
25.2 Temperature influences. (See 31.12, 31.42 and 44.)
25.21 On activity of adults.
25.22 On rapidity of development.
25.221 During winter.
25.222 During summer.
25.223 Proportion of stages at different periods.
25.23 On sex determination.
25.24 Effective temperature studies.
25.3 Proportion of infested fruit producing adults.
25.5 Duration of life cycle. (Localities arranged alphabetically by state and town.)
25.51 Maximum duration.
25.52 Minimum duration.
25.53 Average duration.

26 Habits.

26.1 Food plants. (List by Order, Family, Genus and Species.)
26.11 Portion of plant attacked, and effects.
26.111 Leaf buds.
26.112 Fruit buds.
26.113 Foliage, including petioles.
26.114 Flowers.
26.115 Fruit.
26.116 Seed.
26.117 Stem. (Trunk and branches.)
26.118 Bark.
26.119 Root.
26.12 Tests of other plants for food.
26.13 Susceptibility of different varieties of food plants.
26.19 Occurrence on other than food plants.
26.2 Hosts.
26.3 Prey.
26.4 Feeding habits.
26.41 Larval.
26.42 Adult, male.
26.43 Adult, female.
26.44 Both sexes together.
26.45 Feeding on certain plant species.
26.451 Temperature influence on feeding activity. (See 25.2.)
26.452 Feeding activity in different parts of the day.
26.453 Location of food supply by adults.
26.46 Destructive power by feeding.
26.47 Cannibalism. (See 48.)

2 Life History, *Continued*.

26 Habits.

26.48 Predaceous habits.
26.481 Among larvæ.
26.482 Among adults.
26.49 Movement on food plant.
26.491 During day.
26.492 During night.
26.5 Trap foods. (See 51.1 and 51.2.)
26.6 Adaptive capacity.
26.61 To variations in food supply.
26.62 To variations in climatological conditions.

27 Reproduction.

27.1 Copulation.
27.11 Age at beginning.
27.12 Attraction between sexes.
27.13 In spring before feeding.
27.14 Duration of copulation.
26.15 Polygamy.
26.16 Polyandry.
27.2 Fertility.
27.21 From a single copulation.
27.22 Parthenogenesis.
24.23 Fertility of hibernated individuals.
27.24 Duration of fertility.
27.3 Oviposition.
27.31 Age at beginning.
27.32 Period between copulation and oviposition.
27.33 Portion of plant chosen for oviposition.
27.331 Leaf buds.
27.332 Fruit buds.
27.333 Foliage, including petiole.
27.334 Flowers.
27.335 Fruit.
27.336 Seed.
27.337 Stem, including trunk and branches.
27.338 Bark.
27.339 Root.
27 34 Miscellaneous places for oviposition.
27.35 The act of oviposition.
27.351 Preliminary examination.
27.352 Formation of cavity.
27.353 Deposition of egg.
27.354 Sealing of cavity.
27.355 Time required to deposit an egg.
27.356 Position of female while ovipositing.
27.357 Activity in ovipositing during different parts of day.
27.358 Stimulation to oviposition by abundance of food supply.

2 Life History, *Continued.*

27 Reproduction.

27.359 Number of eggs deposited.
27.36 Selection of uninfested places for oviposition.
27.37 Dependence of oviposition upon food supply. (See 32.7.)
27.4 Effects of oviposition.
27.41 In various portion of plant species.
27.411 (List as under 26.11.)
27.5 Period of oviposition.
27.51 In hibernated individuals.
27.52 In first generation individuals.
27.53 In individuals of other generations.
27.54 First oviposition in season.
27.55 Last oviposition in season.
27.6 Rate of oviposition.
27.61 Daily rate in laboratory.
27.62 Daily rate in field.

28 Protection.

28.1 Egg.
28.11 When deposited internally.
28.12 When deposited externally.
28.13 By isolation.
28.14 By external structure.
28.15 By protective excretions.
28.2 Larva.
28.21 By place of development.
28.22 By external structure.
28.23 By protective devices.
28.231 By repellent odors.
28.232 By protective constructions.
28.233 By protective excretions.
28.24 By habits.
28.241 Concealment.
28.242 Feigning death.
28.243 Feeding internally.
28.25 By fighting ability.
28.26 By locomotion.
28.261 By flight.
28.262 By running.
28.263 By swimming.
28.29 By coloration.
28.291 Mimicry.
28.292 Warning coloration
28.3 Pupa.
28.31 By place of pupation.
28.32 By molted skins.
28.33 By protective constructions
28.331 Cocoons.
28.332 Earthen cells.
28.333 Leaf rolling.
28.334 Gall formation.
28.39 By coloration.
28.4 Adult.
28.41 By place of transformation.

2 Life History, *Continued.*

28 Protection.

28.42 By external structure.
28.43 By protective devices.
28.431 Repellent odors.
28.432 Protective constructions.
28.433 Protective excretions.
28.44 By habits.
28.441 Concealment.
28.442 Feigning death.
28.443 Feeding internally.
28.49 By coloration.
28.491 Mimicry.
28.492 Warning coloration.

29 Multiplication.

29.1 Annual progeny of one pair. (Theoretical.)
29.2 Number of individuals per acre based upon field counts.
29.3 Relation of multiplication to food supply.
29.4 Restrictions upon multiplication. (See 4 and 5.)

3 Seasonal History.

31 Hibernation.

31.1 Entrance into hibernation.
31.11 Time of entrance.
31.12 Temperatures affecting entrance. (See 25.2.)
31.13 Gradual entrance.
31.14 Stages entering hibernation.
31.15 Congregation of individuals preceding entrance into hibernation.
31.16 Mortality occurring at time of entrance into hibernation.
31.17 Activity during hibernation period.
31.2 Shelter during hibernation.
31.21 Apparently favorable conditions.
31.22 Apparently unfavorable conditions.
31.3 Mortality during hibernation.
31.4 Emergence from hibernation.
31.41 Time of emergence.
31.42 Climatic conditions affecting emergence.
31.43 Re-hibernation.
31.44 Number and percentages surviving hibernation.
31.5 Duration of hibernation.
31.51 Localities of observations arranged alphabetically by state and town.

32 Hibernated individuals.

32.1 Finding food supply in spring.
32.11 Distance hibernated individuals will go to food.

3 Seasonal History, *Continued.*

30 Hibernated individuals.

32.2 Nature of first food supply.
32.3 Preferred food supply.
32.5 Duration of life of hibernated individuals.
32.6 Movement of hibernated individuals in field before beginning reproduction.
32.7 Oviposition dependent upon food. (See 27.37.)
32.8 Abundance of hibernated individuals.

33 Progress of infestation.

33.1 Species injury *versus* food production.
33.2 Effect of maximum infestation upon species multiplication.
33.3 Proportion of food supply attacked not destroyed.
33.4 Relation of species to crop production.
33.41 Special crop.
33.411 Percentage of crop destroyed.

34 Dispersion, spread of species. (See 63.)

4 Natural Control.

41 Mechanical control.

41.1 Resistance to attack of species by normal special plant structures.
41.11 Pilosity of stems.
41.12 Appression of floral envelopes.
41.2 Resistance to species attack by abnormal plant growths.
41.21 By gall formation.
41.22 By proliferation in buds.
41.23 By proliferation in seed pods.
41.24 By proliferation in stem.
41.25 By proliferation in root.
41.26 Influence of locality on proliferation.
41.27 Influence of season on proliferation.
41.28 Influence of variety on proliferation.
41.29 Influence of artificial conditions upon proliferation.
41.291 Cultivation.
41.292 Fertilization.
41.4 Artificial stimulation to proliferation.
41.41 In buds.
41.42 In seed pods.
41.5 Mortality in species due to proliferation.
41.51 In buds.
41.52 In seed pods.

4 Natural Control, *Continued.*

41 Mechanical control.

41.6 Manner in which death is caused by proliferation.
41.7 Rearing stages on prolifid cells as food.
41.8 Proliferation started from other causes than species attack. (Arrange alphabetically.)
41.9 Occurrence of proliferation in other plants than special species. (Arrange alphabetically by order, etc.)

42 Restraint upon species attack by habits of growth of food plant.

42.1 Rapid maturing of fruit.

43 Cannibalism. (See 26.47.)

43.1 Among adults.
43.2 Among larvæ.

44 By climatological conditions. (See 02.1.)

44.1 Heat or drying.
44.11 Mortality in picked fresh fruit.
44.111 Buds.
44.112 Flowers.
44.113 Seed pods.
44.12 Mortality in dried hanging fruit.
44.121 Buds.
44.122 Flowers.
44.123 Seed pods.
44.13 Mortality in fallen fruit.
44.131 Buds.
44.132 Flowers.
44.133 Seed pods.
44.14 Heat effect upon adults.
44.141 On hot ground.
44.2 Cold.
44.21 Effects of frosts.
44.211 Upon food supply.
44.212 Upon life of adults.
44.213 Upon life of immature stages.
44.22 Effect of minimum winter temperatures.
44.221 Upon life of adults.
44.222 Upon life of immature stages.
44.25 Experiments in artificial refrigeration.
44.3 Humidity.
44.31 Drought.
44.32 Excessive humidity.
44.4 Precipitation.
44.41 Precipitation deficient.
44.42 Precipitation excessive.

4 Natural Control, *Continued.*

44 By climatological conditions.

44.5 Overflows.

44.51 In summer.

44.52 In winter.

44.55 Experiments in drowning adults, floating.

44.56 Experiments in drowning adults, submerged.

44.57 Experiments in drowning immature stages.

44.58 Experiments in submerging eggs.

45 Diseases of species.

45.1 Fungus diseases.

45.2 Bacterial diseases.

46 Parasites.

46.1 Breeding of parasite species.

46.11 Species list of primary parasites.

46.111 Parasites of egg.

46.112 Parasites of larva.

46.113 Parasites of pupa.

46.114 Parasites of adult.

46.2 Mortality due to parasites.

46.21 In egg stage.

46.22 In larval stage.

46.23 In pupal stage.

46.24 In adult stage. (Arrange data by locality and date.)

46.3 Transference of parasites of other insects to species.

46.4 Hyperparasitism.

46.41 Species list.

46.5 Increasing efficiency of parasites.

46.51 Importation of parasites.

46.511 Transference of parasites from one locality to another.

46.512 Introduction of foreign parasites.

46.52 Artificial propagation and distribution.

46.521 On preferred host.

46.522 By securing concentration on desired host by practices affecting multiplication on alternate hosts.

47 Predatory enemies.

47.1 Insecta. (Arrange by order, genus, and species alphabetically, as suggested in explanation of key.)

47.2 Arachnida. (Arrange as above.)

47.3 Crustacea. (Arrange as above.)

47.4 Pisces. (Arrange as above.)

47.5 Reptilia. (Arrange as above.)

4 Natural Control, *Continued.*

47 Predatory enemies.

47.6 Aves. (Arrange as above.)

47.61 Examinations of bird stomachs.

47.7 Mammals. (Arrange as above.)

5 Artificial Control.

51 Traps.

51.1 Trap foods, unpoisoned.

51.11 Sweets.

51.2 Trap foods, poisoned.

51.3 Trap lights.

51.4 Trap shelters.

51.5 Trap rows.

52 Insecticides.

52.1 Stomach poisons. (Arrange alphabetically.) (See 59.41 also.)

52.2 Contact insecticides. (Arrange alphabetically.)

52.3 Fumigants. (Arrange alphabetically.)

52.9 Other insecticides tested. (Arrange alphabetically.)

53 Repellents. (Arrange alphabetically.)

54 Farm machinery.

54.1 Special machines for the destruction of pest.

54.2 Attachments to machinery commonly used in cultivation of crop.

54.3 Machines for aiding in destruction of food supply.

54.4 Improved machines advisable for general farm use.

55 Treatment of crop after harvesting.

55.1 Temporary storage.

55.11 Cold storage.

55.12 Elevators.

55.13 Cellar storage.

55.2 Mechanical treatment of crop.

56 Restriction of spread.

56.1 Quarantines.

56.11 Regulations of various states. (Arrange alphabetically.)

56.2 Legislative enactments desirable.

56.3 Restricting of movement of crop within border of infestation.

56.4 Disinfection of shipments to points beyond border of infestation.

56.41 Treatment of crop shipped.

56.42 Treatment of cars used.

5 **Artificial Control,** *Continued.*

56 Restriction of spread.

56.7 Restriction of multiplication of species.

56.71 Hand picking.

56.711 Of insects themselves.

56.712 Of infested fruit.

56.72 Burial by cultivation.

56.721 Of insects themselves.

56.722 Of infested fallen fruit. (See 57.5.)

56.73 Trapping hibernated individuals. (See 51.)

56.74 Destruction of favorable hibernation quarters.

56.75 Proper spacing of rows and plants.

56.76 Fall destruction of food supply. (See 54.3 and 57.7.)

56.77 Rotation of crops. (See 57.9.)

57 Cultural methods of control.

57.1 Selection of best seed.

57.2 Thorough preparation of soil.

57.3 Fertilization.

57.4 Early planting or uniform planting.

57.5 Thorough cultivation.

57.6 Early harvesting.

57.7 Early destruction of annual plants.

57.8 Fall breaking of land.

57.9 Rotation of crops.

59 Experimental farm work.

59.1 Data regarding locations.

59.11 Alphabetical list of localities arranged by years.

59.12 Alphabetical list of names and addresses of owners and operators of farms.

59.13 Geological conditions represented by farms.

59.14 Climatological conditions represented by farms.

59.15 Proposals for experimental work.

59.16 Contracts for experimental work.

59.2 Data regarding experiments with crops.

59.21 Early planting tests.

59.22 Late planting tests.

59.23 Variety tests.

59.24 Fertilizer tests.

59.25 Cultivation tests.

59.26 Soil tests.

59.27 Isolation tests.

5 **Artifical Control,** *Continued.*

59 Experimental farm work.

59.3 Data regarding insect conditions. (Arrange by locality alphabetically and chronologically.)

59.4 Data regarding remedial experiments.

59.41 Paris green experiments.

59.411 Applied as dust.

59.412 Applied as spray.

59.45 Cultural remedial experiments.

59.5 Data regarding cultural conditions.

59.51 Preparation of soil.

59.52 Fertilization given.

59.53 Time of planting.

59.54 Cultivation given.

59.55 Destruction of plants.

59.56 Fall treatment of soil.

59.6 Data regarding crop conditions.

59.61 Germination.

59.62 Growth before flowering.

59.63 Flowering.

59.64 Setting of fruit.

59.65 Harvesting.

59.66 Yield.

59.67 Foliage area.

59.68 Number of plants per acre.

59.7 Data regarding climatological conditions.

59.8 Methods commonly used by most successful farmers.

59.81 For special crop. (List by name and address.)

59.9 Data regarding results.

6 **Distribution of Species.**

61 Geographical distribution.

61.1 Alphabetical list of recorded localities arranged by the state, county and town.

61.2 Maps showing distribution.

62 Status of species.

62.1 Inspection reports.

62.11 Species found present.

62.12 Species not found.

62.2 Special studies of areas of especial abundance of species.

62.3 Special studies of areas of especial scarcity of species.

63 Dispersion (spread) of species.

63.1 By natural agencies.

63.11 By flight.

63.111 In spring, seeking food.

63.112 In midsummer.

63.113 In fall.

6 Distribution of Species, *Continued.*

63 Dispersion (spread) of species.

63.114 When going into hibernation.
63.115 Seasonal influence upon taking flight.
63.12 By crawling.
63.13 By winds and storms.
63.14 By water along waterways.
63.15 By floods and overflows.
63.16 By artificial carriers, not hosts.
63.17 By movement of hosts as carriers.
63.2 By artificial agencies.
63.21 By shipments of infested materials.
63.22 By movement of containers which have carried infested materials.

6 Distribution of Species, *Continued.*

63 Dispersion (spread) of species.

63.221 Cars.
63.222 Barrels and other containers.
63.223 Harvesting apparatus.
63.23 By movement of carriers only accidentally related to pest.
63.231 Vehicles passing infested fields or near plants.

7 Collection.

71 Classification. (Orders alphabetically.)
72. Accessions catalog.
73 Species catalog.
74 Description list, new species described.
75 Type list and disposition of types.

In discussing the paper Mr. Hunter stated that the system described was a modification of the one used by Mr. Quaintance and was especially valuable in cases where a large amount of data on an insect must be kept so that it can be available for easy reference.

Mr. Felt preferred to use a method that was simpler than the Dewey system, as it took considerable time to train assistants so they could use it to advantage. By means of the system in his office it was impossible to lose any of the note sheets.

Mr. Hart stated that there is little danger of losing sheets or cards. The system in use in Dr. Forbes' office is essentially somewhat similar but not numerical. The great advantage of the system described by Mr. Bishopp is in keeping before the eye the points which should be investigated.

Mr. J. L. Phillips considers the Dewey system a valuable one for arranging correspondence for easy reference. He uses a modification of this system, arranging the counties alphabetically, as well as giving each county and correspondent a number and using decimals to make further sub-divisions for each county. This method is specially valuable where it is necessary to keep in touch with a large number of county inspectors and persons in the inspectors' territory who write about this line of work. Under such a system it is easy to refer at once to the correspondence on this subject with people in any county without going to the card index. All this correspondence can be taken out of the files, examined and returned in a few minutes, while under other systems it would be necessary to keep a cross index, and the cor-

respondence with any one person would be kept in a separate folder. The method outlined above does not require any extra work and very much less time is needed to refer to the correspondence from any one county. This method presupposes, of course, that carbon copies of letters are filed instead of using the letter book system.

Owing to the lateness of the hour, the meeting adjourned until 9.30 a. m. Saturday, with the understanding that the two papers remaining on the program be read first.

Morning Session, Saturday, December 28, 1907

Arrangements had been made for a joint meeting of this association and the Association of Horticultural Inspectors and the program had been arranged accordingly. The session was called to order at 9.30 a. m. by President Morgan, and the following paper was presented:

BEE DISEASES: A PROBLEM IN ECONOMIC ENTOMOLOGY

By E. F. Phillips, *Washington, D. C.*

Bee keeping in the United States is a sole means of livelihood to a comparatively small number of persons, but taken as a whole it forms an industry which commands recognition. Every year the manufacturers of supplies in this country make from 60,000,000 to 75,000,000 sections for comb honey and practically all of these are used in the United States. A study of market conditions will reveal the fact that there is three or four times as much extracted honey as comb put on the market, mainly because of the heavy demand for confectionery and baking purposes. A species of insect which forms the basis for an industry adding from $20,000,000 to $25,000,000 to the resources of the country annually is well worthy of consideration in economic entomology.

No one conversant with bee keeping conditions would claim that the entire field is now occupied. It is safe to say that many times as much nectar goes to waste and dries up annually as is gathered by honey bees; probably this country could produce ten times the present yearly honey crop were there more and better bee keepers properly located. In attempting to aid in the building up of this industry, it is necessary to determine the causes which prevent its rapid growth. The two principal causes seem to be too general an ignorance of modern methods of manipulation, and the brood diseases of the bees. The education of all bee keepers to proper methods is no small un-

dertaking, but the other impediment will effectually prevent advancement unless handled vigorously.

There are now recognized two diseases of the brood which are infectious in their character: These are designated American foul brood and European foul brood. While they differ in their cause and symptoms, their ultimate effect is similar. The brood succumbs to the disease and the colony dwindles from a lack of young bees to replace the old workers, which die of old age. Finally the colony is entirely destroyed. It is now definitely determined that American foul brood is caused by a specific micro-organism, *Bacillus larvae,* and probably European foul brood is caused by some other micro-organism, since it is equally infectious and spreads in the same manner.

When a colony dies from disease, bees from another colony rob the hive and thus carry infection to their own hive. Disease may also be spread by feeding a colony honey which has been extracted from a hive containing disease and by introducing queens which come in cages containing candy made with infected honey.

The investigation of the causes of these diseases has attracted the attention of scientists for many years. In Europe, at present, there are several bacteriologists at work on the subject and it is also one of the lines of work now being pursued in the agricultural investigations of the Bureau of Entomology. The work so far done indicates that the problem is by no means an easy one and that it should be investigated by well trained men. The work has, in fact, suffered from the publications and statements of untrained men, and it is to be hoped that in the future it will not be necessary to spend more time pointing out the mistakes in immature work.

The control of these two diseases is the great economic problem now confronting those interested in this industry. The present approved method of treatment for both diseases consists of the removing of all infected material from the colony and in compelling the bees to build new, clean combs. Perhaps, when the characteristics of the causal micro-organisms are better known, it may be possible to devise methods for the use of disinfectants or drugs to save the comb, but until more information is available, the use of drugs, either for feeding or for fumigation, cannot be advised. Several attempts have been made to save the combs by fumigation with formalin, but this is only experimenting in the dark, and it is safe to recommend only such methods as are known to be effective.

While it is possible for any bee keeper to eradicate either disease from his apiary, it is difficult to get all bee keepers to do it; and care-

less or ignorant persons, who do not treat the disease, harbor a menace to all the bee keepers in the neighborhood. For this reason, inspection of apiaries for disease has been instituted in several states. As in the case of all inspection, the work of these men is not only that of a police officer empowered to enforce the law, but it is also largely educational. Good results have come from this supervision in almost all cases, and they follow whenever a thorough man is in charge of the work. In several states not now having inspection of apiaries, the bee keepers are asking for its institution; and it seems probable that before long this phase of the work will be well under way whenever either disease is severe.

The present weak point in state inspection seems to the writer to be a lack of the proper kind of supervision of the inspection. The inspectors are usually good practical bee keepers and are experts in the detection and treatment of disease. As a rule, however, they know little of the methods used in other lines of inspection and are equally uninformed on all other phases of entomological work which would be valuable for purposes of comparison. It would seem desirable, therefore, that apiarian inspection be under the supervision of the state entomologist; not that the entomologist himself should do the work, for he has enough to do, but that the inspector should be responsible to him. In fact, in most cases, a practical bee keeper would be better able to handle disease than the entomologist who may not be trained in the practical manipulation of bees, which is an absolute essential to effective work. In Texas the state entomologist is also foul brood inspector, but has four assistants who do the actual inspection.

I would not have any of the previous statements interpreted as reflecting adversely on the present inspectors; their work commands the highest respect, with but few exceptions. The official entomologists may feel that such a recommendation tends to impose additional arduous duties on men already overworked, but apiculture is a branch of economic entomology, and the honey bee, as a most beneficial insect, demands attention. The only reason for suggesting this supervision by the state entomologist is the belief that an entomologist is better able to direct in this work than any other state official. If the entomologist is also a trained bee keeper, the efficiency of the work would be inestimably increased.

Even if the state law does not specify that the entomologist shall have supervision of this inspection, he may be of the greatest value, not only in the eradication of bee disease, but in the furtherance of the bee-keeping industry, by giving out information concerning im-

proved manipulations and by getting bee keepers in touch with persons who can give them information which may be desired. This need is felt in the apicultural work of the Bureau of Entomology. To spread information concerning new results obtained in our own investigations, or those of others, it is very desirable that there be some person nearer to the bee keeper who can give out the information. At present, in the majority of cases, our only means of reaching the persons whom we aim to assist is by direct communication or through the bee journals. If the official entomologists took more interest in apicultural work, we feel that it would bring new work nearer to the honey producer, even if no new investigation were undertaken by the entomologist himself. For this reason, it is earnestly desired that in the insect work in each state, apiculture may have a part.

As far as the apicultural work of the Bureau of Entomology is concerned, it is requested that material be sent in to aid in the investigation of bee diseases. An effort is being made to learn the geographical distribution of the two diseases, so that this information may be available in sending out publications to the bee keepers in infected regions. The same information would be valuable in trying to have new inspection laws passed. We now get many samples from bee keepers direct, but need many more, and the assistance of official entomologists will be greatly appreciated.

This paper brought out considerable discussion. In reply to a number of questions, Mr. Phillips stated that the diseases of bees have spread to a far greater extent than was supposed, and that he is particularly anxious to obtain samples from suspected hives from entomologists and bee keepers throughout the country. The best time to inspect apiaries is during the summer months, and all hives in a state should be examined. He called attention to the ignorance of some of the inspectors now doing this work. In one of the western states his attention had been directed to an inspector who examined the honeycomb by piercing it with an awl. The same instrument was used throughout the district, without disinfection, and in this way the disease had become generally established.

Mr. Britton remarked that a law providing for the inspection of apiaries is pending in Connecticut and Mr. Washburn stated that in Minnesota some of the leading bee keepers desired him to take charge of this work, but he had considered it inadvisable to do so.

Mr. Bruner called attention to the habit in Nebraska of desiring

inspection and work of all kinds to be carried on by the entomologist, but of the tendency of the legislature to make no appropriation for the purpose of paying for such additional service.

A paper was presented as follows:

SHOULD STATE DEPARTMENTS CONDUCT PUBLIC SPRAYERS?

By T. B. Symons, *College Park, Md.*

As the title of this paper indicates, the object in view is to bring out a general discussion of this subject rather than discuss it at much length from my standpoint. It was a question in my mind whether it was even appropriate to present it to this meeting, but after mentioning this fact to our secretary, he was good enough to place the same on the program.

I believe that we all feel much gratification at the great progress made throughout the country in the application of insecticides and fugicides during the past few years. These improved conditions in the treatment of many crops to control the various pests have been brought about by numerous agencies. The increased number and activity of many common pests has led to greater efforts, not only by the growers themselves, but by those charged with the duty of aiding in controlling the pests in the United States Department of Agriculture, the state departments, the agricultural colleges and experiment stations and other organizations, and not the least by private manufacturers of various insecticides.

Referring particularly to the San Jose and other scale insects as well as other common pests, I believe that you will all agree with me in stating that the progressive orchardists or growers of other crops have no fear of the more common pests, especially the San Jose Scale or those that can be controlled by efficient spraying. If this is the case, and it is so far as the territory with which I am familiar is concerned, is it not our duty to spend every effort to bring about this condition among the small growers, who many times only grow fruits especially for the home consumption, and particularly those persons in small towns and villages who may have only a half dozen trees in the backyard which need treatment, but the trouble and expense of securing spraying apparatus and time for the work, as well as knowledge of conducting the same, are difficulties which many of them will not surmount, even if they are inclined to give the trees or plants attention.

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I believe the aim of all of us to continually induce the grower to secure his own spraying apparatus is the correct one, for there is no doubt of its desirability, not only for spraying, but for other purposes on the farm, and the convenience of being able to conduct spraying when opportunity and favorable conditions present themselves. It also has been our aim in Maryland to induce persons to conduct public sprayers in different parts of the state, where their service is needed, but we have signally failed in promoting such business enterprises, due I believe in part to ignorance on the part of those persons who could undertake it and the consequent failure to recognize the opportunity for a remunerative income.

Thus from time to time requests from small growers or citizens in towns who have infested trees would come and still come to my office, reading something like this: "If you will advise me who I can secure to do my spraying, I will gladly order same done, but circumstances are such that I cannot do it myself." This condition existing in many parts of our state led us to devise some means of meeting it.

In providing public sprayers, the following points were to be considered:

First, Should a state department conduct public sprayers? Is it a good policy to pursue?

Second, How should they be conducted, as a source of income, or expense, or should charges be made to cover costs and general expenses?

The board of trustees permitted me to give the matter a trial, conducting them on a basis to cover all expenses. Accordingly, we located three rigs in different parts of the state with the especial purpose of treating orchard, shade or other trees and also small orchards in small towns and villages for San Jose Scale or other scale insects.

It is only necessary to discuss briefly the operation of one in this paper.

The rig, which consisted of an eclipse barrel sprayer fitted with two leads of hose, small boiler and other vessels, horse and wagon, etc., carrying materials for making the lime sulphur solution, commenced work in Hyattsville, Maryland, about March 20th, 1907. It continued to work during favorable weather until about April 25th, when the opening of the buds prevented. In this time it visited over forty-five different places and sprayed effectively about twenty-five hundred trees and considerable ornamental shrubbery, hedges, etc., with the lime sulphur wash. Under the excessive charges for labor and team incurred by this rig, a charge of 10c per tree was made to

cover expenses in spraying ordinary trees, but the cost, of course, depended upon the size of the trees, their accessibility and the number at one place. In some cases a greater charge was made, but 10c was about the average. I may add that no complaint was made with any charges imposed and where there is a small orchard to be treated, a charge of 5c per tree will cover costs.

The citation of the work of this sprayer can not be taken as what a similar rig can do under ordinary or favorable conditions, as there were many obstacles which entered into its operation to prevent maximum work.

The operation of the three in different parts of the state demonstrated that they filled a long-felt want and that the public sprayer could be conducted without expense to the department. They were popular in each district operated and there is a demand for many more in other parts of the state this coming season. Our aim in inaugurating this work was first to afford immediate relief in the treatment of trees that otherwise would have been killed or served as distributing agencies for these pests, and second to demonstrate to our people that a public sprayer can be conducted on business principles; with the final aim and desire that private persons would relieve the department by taking over these spraying outfits and conducting the work as a private business. This was the result with one of the outfits started last spring. The man having charge of it desires to conduct it privately this winter and spring.

The question is asked: That in states where the San José, oyster shell and other scale insects or other important pests to our fruit or shade trees as well as pests of other crops are generally disseminated and controlled similarly, should we confine our energies in either conducting spraying demonstrations or advising what should be done, or should we do everything where conditions will permit to provide means in order that the citizens of our small towns and villages, as well as suburbanites and small growers, can have their trees effectively treated at a reasonable cost?

In conclusion, it is unnecessary to add that the conducting of these public sprayers entails a considerable amount of executive and detail work, which takes one's time from experimentation and investigation, but is it not our duty to employ to the greatest advantage the remedies already known for many of our destructive pests?

I would be glad to hear some discussion on this subject as to the manner in which these conditions are met in other states and the opinion of members as to policy of state departments conducting public sprayers.

Mr. J. B. Smith stated that conditions in Maryland are very similar to those in New Jersey. In the latter state the Experiment Station does not consider it advisable to conduct public sprayers. In fifteen or twenty localities spraying is being attempted in a wholesale way by private individuals, and the Station is doing its best to encourage this kind of work.

Mr. Burgess considered the work which Mr. Symons had described as very important and believed that after parties had been properly trained by the state force, that many of them would take up spraying as a business enterprise. This would relieve the state department and give the owners of trees an opportunity to secure competent men to do their work.

Mr. J. L. Phillips favored starting the work in this way and encouraging private parties to continue it.

Mr. H. T. Fernald remarked that more spraying is now being done than ever before, but that in spite of this, losses caused by insect pests are increasing. Under such conditions, there seems to be a question whether present methods of control will ever be sufficiently effective by themselves, and he believed that the time had come to search for new and better methods than those at present made use of, to add to our present weapons.

Mr. Fletcher called attention to the wonderful development in all lines of economic entomology in the last few years. This shows that the entomologists have been working as well as the insects. The world has never seen such work in economic entomology as that being carried on in Massachusetts against the Gypsy moth and in Texas against the cotton boll weevil. During the past year the United States government appropriated $650,000 to fight insects, a thing which ten years ago would have been considered utterly absurd. He believed that what is needed is more work of the same nature as is now giving good results.

Mr. Fernald replied that he recognized that many new lines are now being worked on, and the importance of paying attention to these is the point he wished to urge. The cases of the Gypsy moth and boll weevil work are examples of what he had in mind, for in spite of all that is being done to control these pests, the area of infestation is constantly extending. He felt that spraying and other methods now in use are of great value, and that we cannot afford to neglect them, but after all, they alone would prove insufficient and that it is the duty now of the economic entomologist to investigate all possible lines of the subject in the hope of discovering other methods of control to add to those already in use.

Mr. Sanderson was decidedly of the opinion that the New Hampshire fruit grower should spray. If new and better methods of controlling insect pests are being investigated they should not be announced until their utility is thoroughly demonstrated.

Mr. J. B. Smith stated that he did not believe that entomologists should hold back information or suggestions which might be of benefit to their constituents. If the people of one state were twenty-five years behind the times, it did not seem right to wait for them to catch up with the procession.

Mr. Bruner gave a statement of some interesting experiences which he had in Nebraska, with special reference to the distribution of fungus diseases affecting insects. As a general proposition he did not consider these diseases a particularly valuable means of controlling injurious insects.

Mr. Britton presented a paper entitled:

TESTS OF VARIOUS GASES FOR FUMIGATING NURSERY TREES

By W. E. Britton, *New Haven, Conn.*

The object of these tests which I am about to describe briefly was to ascertain if there is not some gas that can be used more conveniently than hydrocyanic acid gas, especially in fumigating small lots of trees, cions and bud sticks. For this purpose it is necessary that the materials be reasonably inexpensive and comparatively harmless to the operator as well as to the trees. We therefore selected carbon disulphide, carbon tetrachloride, sulphuretted hydrogen and chlorine, and for purposes of comparison a few tests were made with hydrocyanic acid gas, the latter being given three different quantities and three different periods of time. These tests are merely suggestive, and no conclusions should be drawn until more work has been done. We are not yet recommending that hydrocyanic acid gas be replaced by any of the others tested.

The trees were fumigated in a long narrow box containing ten cubic feet of space. In order to ensure a more uniform distribution of the gas, two generating dishes were used, one being placed near each end.

The trees were apple and peach of several standard varieties, all more or less infested with San José scale, though none so badly as to affect seriously their vitality. Roots and tops were both fumigated and the trees properly labeled and planted in nursery rows, where they could be watched during the season. For comparison untreated trees were planted alongside to serve as checks.

As we had no basis from which to compute quantities of some of these gases, guesswork had to be employed, but we sought to kill the scale, and expected that many of the trees would be injured. I am now convinced that further tests, especially with carbon tetrachloride, in smaller quantities, are desirable, and possibly it may prove to have some value as an insecticide.

Volatile Liquids

Carbon disulphide.—Preliminary tests taught us that there is more or less trouble in volatilizing the liquid rapidly at ordinary temperatures. Where a large quantity is used, the period necessary for volatilization is so long that the roots may dry out and the trees are injured. Cast iron stew pans were adopted as generating dishes, and after heating to nearly 200° F., one was placed near each end of the box above the trees. A small hole through the cover of the box enabled us to pour the liquid through a funnel into the heated dish. The holes were stopped with corks and the carbon disulphide all volatilized in a few seconds or minutes, according to the quantity, while without the heated dishes several hours were necessary in some cases. Quantities of the liquid varying from ten to eighty fluid ounces per one hundred cubic feet of space were given periods of time varying from one to four hours. At the rate of ten ounces per one hundred cubic feet for one hour, 4.3 per cent of the scales survived, and one tree died. Similar proportions for the same time at 59° F. (the dish not being heated) gave a surviving percentage of 19.2 per cent. Aside from these all scales were killed, and no trees injured until given a period of three hours with a quantity of carbon disulphide equivalent to sixty ounces. Above this about half of the trees failed to grow.

Carbon tetrachloride.—The quantities used of this liquid varied from one to eight ounces, and the fumigating period from two to six hours. All scales were killed, and no trees were injured, where thirty ounces per one hundred cubic feet or less of the liquid was used, with a fumigating period of two hours. Greater quantities of the liquid caused injury, and killed some of the trees. This liquid was also volatilized by means of heated pans. It is non-inflammable, and is not very poisonous to the higher forms of animal life.

Gases Generated by Chemical Action

Hydrocyanic acid gas.—This gas was generated in the usual way with one ounce potassium cyanide, two ounces sulphuric acid and four ounces water for each one hundred cubic feet of space. In each case all scales were killed. In one case where these qauntities were used

and the stock fumigated for one half hour, one tree out of ten died. In another case where the same quantities of chemicals were used and the stock fumigated two hours, one-tenth of the trees failed to grow. In all other cases of tests with this gas the trees lived and grew nicely. The largest quantity used was three ounces of cyanide, and the fumigation period was one-half hour. Two ounces for two hours produced no injury.

Sulphuretted Hydrogen.—Generated from iron sulphide, sulphuric acid and water in the following proportions:

Iron sulphide	20 ounces
Sulphuric acid	80 ounces (fluid)
Water	32 " "

In this proportion nine, twelve and one-half, and twenty-five pounds of iron sulphide per one hundred cubic feet of space for one hour were employed, the last quantity only causing injury to the trees. Where this amount was used and the trees fumigated for two hours, only two out of ten trees were killed. The scales were killed in all cases.

This gas was rather inconvenient to use, as it takes a long time to generate it.

Chlorine.—Generated from bleaching powder, sulphuric acid and water in the proportions given below:

Bleaching powder	14 ounces
Sulphuric acid	17 ounces (fluid)
Water	70 " "

The quantities used in these tests varied from 8.6 to 34.7 pounds per one hundred cubic feet, and were probably all excessive. As we expected, all of the scales and most of the trees were killed.

In reply to a question, Mr. Britton stated that he had not used acetylene gas for fumigating fruit trees. Carbon tetrachloride appeared worthy of further test.

Mr. Hunter mentioned the fact that Mr. Sanborn had used acetylene gas to destroy plant lice on cucumber plants in Texas.

Afternoon Session, Saturday, December 28, 1907

On re-assembling at 1 p. m., three papers relative to the cotton boll weevil work were presented, as follows:

THE POSSIBILITY OF REDUCING BOLL WEEVIL DAMAGE BY AUTUMN SPRAYING OF COTTON FIELDS TO DESTROY THE FOLIAGE AND SQUARES

By WILMON NEWELL and T. C. PAULSEN, *Baton Rouge, La.*

The most important step in insuring a good crop of cotton in the boll weevil infested region of the South is the early fall destruction of the cotton plants in order to kill the immature stages of the weevil contained in the squares and bolls, to destroy the food supply of weevils already adult and to lengthen the period through which the insects must survive until the appearance of the following year's crop. So completely has this been demonstrated by the experiments of the Bureau of Entomology in Texas, and more recently by Prof. W. D. Hunter in an enormous field experiment in southern Texas, that discussion of this point is entirely unnecessary.

The great objection upon the part of planters to fall destruction of the cotton plants is that the cotton crop cannot be picked out early enough so that the plants can be uprooted and burned at the time necessary to insure destruction of the greatest number of weevils, for the labor problem in Texas and Louisiana is at present second in importance only to the boll weevil problem itself.

A method of practice which would destroy the weevils and their food supply (leaves, squares and green bolls) early in autumn and at the same time permit greater leisure for gathering the crop, has long been recognized as a desideratum. The possibility of spraying to destroy all green portions of the cotton plant, without affecting thereby the lint in bolls still unopened, was discussed at length as much as two years ago by Prof. W. D. Hunter and the senior author. At that time we saw no possibility of the plan being practical.

During the past summer the subject was again brought up by Dr. T. J. Perkins, an extensive planter of Redfish, La. Doctor Perkins had had experience in destroying the water hyacinth with sprays, and being also a practical cotton planter, he believed that the same plan could be made applicable in the warfare against the weevil.

The writers accordingly decided to make a few experiments in a small way to determine what could be accomplished along this line. We first experimented with substances which we knew to be destructive to plant life, such as common salt, white arsenic, copper sulphate, etc.

Through the courtesy of Capt. J. F. McIndoe, Corps of Engineers, U. S. A., we were furnished with directions for preparing the mixture of white arsenic and sodium carbonate used so successfully by

the army engineers in destroying the water hyacinth in the bayous and navigable streams of the southern states. The cost of the ingredients, and particularly of the arsenic, showed that the use of this preparation, even though it might meet all requirements, would involve an outlay too great to make its use profitable in the cotton fields.

It was also thought that the cotton plants might be killed by "girdling" the base of each with a flame from a gasoline blow torch, and this was accordingly tried. With cambium layer and bark entirely burned off, the plants died immediately and the green bolls afterwards opened fairly satisfactorily. However, a much more severe burning was necessary to kill the plant than was anticipated, from five to ten minutes' application of the flame to the base of each plant being necessary to insure death. On account of the labor involved this method was put aside as impracticable.

Spraying solutions were next tested, most of the experiments being made during the month of September. Several healthy plants were sprayed by hand with each solution tested, with the general results indicated below.

A 5% solution of common salt burned the foliage rather severely and caused some of it to shed, but the plant continued to grow and put on foliage and squares. The application of the salt solution to the larger unopened bolls caused them to open suddenly, without the lint maturing properly.

A 5% solution of bicarbonate of soda produced little effect, except that some leaves and squares were wilted. In six days after spraying the plants had practically recovered and were growing rapidly.

A 5% solution of ordinary lye severely burned the foliage and caused many leaves and squares to fall. It also seemed to sear the unopened bolls severely and the plants almost immediately started to put on a new growth. The caustic nature of the solution was also objectionable.

A 2% solution of hydrochloric acid burned some leaves and caused about 40% of the foliage to drop, but in two days' time an abundance of new foliage and fruitage was being put forth.

A 3% solution of white arsenic in water, dissolved by long continued boiling, killed the cotton plants outright and no "second growth" appeared at any time after spraying. The larger bolls were however forced open almost at once, with the result that the lint and seed had no opportunity to mature.

A solution containing 5% of white arsenic and 3% of carbonate of soda did not produce effects materially different from those produced by the 3% arsenic solution. All the foliage was killed, the larger

bolls opened and furnished fair lint, with improperly filled seed, while the smaller bolls either dropped off or decayed after opening slightly.

Copper sulphate used at the rate of 5 lbs. to 50 gallons of water scorched the foliage slightly and induced gradual shedding of leaves. This shedding, however, was accompanied by a constantly increasing rejuvenescence of the plants.

A 10% solution of iron sulphate killed leaves, squares and the smaller bolls.

A 5% solution of iron sulphate was next tried. The action of this solution was more gradual than that of the 10%. In 24 hours after application some leaves were burned. Three days after the application blossoms and forms were dead and on the fourth day the shedding of leaves, squares and forms was well under way. By the fifth day there was practically nothing upon the plants that could serve as food for the weevils. This slow killing of the foliage also gave the large bolls, not open at time of spraying, an opportunity to mature, for on the fifth day also the first of these opened. For several days afterwards these bolls opened rapidly and from those that were three-fourths grown or over at the time of spraying, fair lint was secured. Lint in bolls which were *open* at time of spraying was slightly discolored. Later a very few green shoots were put out by these plants. We have given the results of this experiment thus in detail for iron sulphate meets the requirements better than any other substance tried and it is also the cheapest.

The iron sulphate and salt solutions having separately proved the most promising, they were tried in combination. A solution containing 5% of each did not show any advantage over the 5% solution of iron sulphate used alone, and the plants sprayed with the former took on new growth to a marked extent.

Combinations of iron sulphate and white arsenic were tried, but gave no indication of being better than iron sulphate alone.

A 1% solution of iron sulphate was not found to be strong enough. A 3% solution of the same material was practically as effective as the 5% solution, except that the plant recovered to a certain extent and in a couple of weeks put out more new foliage than was desirable.

Taking a comprehensive view of these experiments, we see that arsenic solutions proved effective in killing the plants, but are too expensive, while iron sulphate solutions meet the requirement of killing the plants slowly, while at the same time permitting the larger bolls to mature and open. The latter—nearly grown bolls—it may be remarked, are the ones which are lost when the plants are uprooted and burned; smaller bolls would not figure in the production, as in

ordinary seasons they would be killed by frost, even were the plants not destroyed. Copperas, or iron sulphate, may be purchased in quantity at from 1 to 1½ cents per pound, hence weak solutions of it are not expensive.

We have made no attempt to experiment with these solutions on the scale of field operations, as time did not permit. There still remains the problem of applying this copperas, or other solution, to the cotton plants with a mechanical sprayer, making the application thorough enough to be effective in destroying the weevil's food supply and at a labor cost sufficiently low to make the method practicable. In this connection, however, it should be borne in mind that the lint contained in the grown and nearly grown bolls at the time fall destruction of the plants must be practised, constitutes a considerable part of the crop in weevil-infested sections, and by the amount of lint secured from such bolls, if the spraying prove otherwise successful, must we compute the loss or gain from such an operation.

From the foregoing it will be noted that destruction of the foliage, squares and blooms on the plants sprayed with the various solutions was usually followed in a week or ten days by new shoots and leaves being put out by the plant. Our experiments were made during the early part of September, just after the period of intense summer heat and just prior to the time when the second growth normally appears in all cotton fields. Should spraying to destroy the foliage be found efficient such spraying would be done, not in September, but between October 15 and November 1, at a time when little if any second growth would ordinarily be induced. We do not think therefore that the factor of rejuvenescence in the plants following the spraying would, under field conditions, militate against the success of the method.

The discoloration of lint in bolls open at the time of spraying would not be a difficulty hard to overcome, as it would only be necessary to have the spraying machine follow the pickers, thus spraying the cotton when no bolls are open.

THE FIRST AND LAST ESSENTIAL STEP IN COMBATTING THE COTTON BOLL WEEVIL

By W. E. Hinds, *Auburn, Ala.*

(Withdrawn for publication elsewhere.)

Mr. Sanderson remarked that these papers bring out in detail the fact which he had previously demonstrated, that the cotton stalks must be destroyed in the fall.

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Mr. Hunter stated that the farmers in the section where his experiment was tried were anxious to have it repeated this year.

A LARGE SCALE EXPERIMENT IN THE CONTROL OF THE COTTON BOLL WEEVIL

By W. D. HUNTER, *Washington, D. C.*

(Withdrawn for publication elsewhere.)

A paper was read as follows:

THE ECONOMIC BEARING OF RECENT STUDIES OF THE PARASITES OF THE COTTON BOLL WEEVIL

By W. D. PIERCE, *Washington, D. C.*

The utilization of parasites in the control of injurious insects generally has taken only the form of introduction from other localities or from foreign countries. Notable instances may be cited in the introduction of *Scutellista cyanea* from Africa into California to combat the black scale (*Saissetia oleae*), and the very recent introduction of this same parasite from California into Hawaii, there to attack a different species of scale in the same genus. The successful introduction of *Rhogas lefroyi* from southern India into the Punjab by Mr. Maxwell Lefroy in order to restore the former condition of control of the bollworm by this species, which was killed out by the cold winter, and the more important fact that where introduced the parasites regained much of their former control is another example of the same kind. Mr. F. M. Webster, in a paper read before this association last winter, cited a number of important cases of valuable parasites in the control of cereal and grain crop insects.

Contrary to earlier suppositions, it is now apparent that parasites and predatory insects bear a very considerable part in the control of the boll weevil. It is important to note that the boll weevil parasites are indigenous species that have been attacking native weevils, but which now, in many instances, seem to be transferring their attention to the great enemy of the cotton plant. Since the control by these inimical insects can be aided by several distinct methods of practice, it is considered justifiable to present the following remarks:

The preliminary studies which have been necessary in order to perfect any methods of economic treatment have involved the collection and individual examination of infested cotton forms during 1906 and 1907 which have contained over 54,000 weevil stages, exclusive

of eggs and very young larvae killed by the proliferation of plant tissue. These were gathered at many places over an area of approxmately 200,000 square miles, at many times and are representative of all the component biological or geographical regions infested by the boll weevil in the United States.

During 1907 the average control of the weevil by parasites was ten per cent against four per cent in 1906. They are not, however, the principal element of control. Out of 62 per cent mortality in 1907, 32 per cent was due to heat and other climatic conditions, while 20 per cent were killed by predatory ants. This gives then 30 per cent as the sum of insect control.

The utilization of these insects belongs in three distinct groups of economic treatment. The most important group consists in the application of strictly cultural methods to farm practice and is therefore under the control of every cotton grower. The next group takes advantage of the known rotation of hosts and also belongs under farm practice. The third group is the simple introduction of parasites and is really in many cases preliminary to the two preceding.

The first mentioned group of methods involves early planting, wide spacing, and the use of determinate, short limbed, square retaining varieties of cotton, as explained in the following paragraphs.

The study of the activity of the parasites on weevil stages in different conditions demonstrated that the most favorable condition for parasite work was the dried hanging square. It appears that when the weevil attacks the squares or bolls the plant produces a corky absciss layer which causes the infested form to fall to the ground. There is a decided tendency among certain varieties and less so in all varieties to fail in forming a complete absciss layer and hence the infested part is caused to hang. When this has become dry, it affords the best possible condition for parasite attack since most Hymenopterous parasites require heat and light for successful work. During 1907 the average parasite control in hanging squares was 30.45 per cent, in fallen squares 4.67 per cent, in hanging bolls 5.44 per cent, and in fallen bolls 2.5 per cent. This positive demonstration of preference contributes a suggestion for economic application. It may be possible that plant breeders can develop a variety of cotton which will have this tendency in such a marked degree, that the possible parasite control will exceed the total control by all causes in varieties which shed all infested forms. At present the total control in hanging and fallen squares does not greatly differ.

Careful studies have demonstrated a preference for squares fallen in the sun over squares fallen in the shade, and for fallen squares on

the prairie over fallen squares in wooded country. The reason is obvious enough. The parasites choose the dryest and lightest condition to be found. These very valuable observations give strong confirmation to the value of the cultural methods, in particular the recommendations that the cotton be planted in wide rows or checked and that determinate varieties and varieties with the least amount of foliage be used.

A comparison of fields in like conditions, except for the time of planting at several different places, shows that the earliest planted field in each case fared the best through the early part of the summer at least. This is believed to be because of the rotation of hosts by the parasites, and the possibility of the hibernated parasites attacking the boll weevil as the first or second spring host in the earliest planted fields, and the necessity for one or more generations on other hosts in the latest planted fields. The fact remains, however, that early planting is advantageous.

The second group, or control by the rotation of hosts, consists of the encouragement of the spring host plants for co-host weevils, the elimination of summer host plants in order to force over the parasites, and the fall destruction of the cotton plant to insure hibernating co-hosts for the parasites.

At present the average percentage of parasitism is very variable for localities quite close together. This is directly due to the very peculiar distribution of the parasites. No one species is of primary or even secondary importance over the entire infested territory. Six species are known to hold these positions in various portions of our territory. They are, in order of greatest importance *Bracon mellitor, Catolaccus incertus, Eurytoma tylodermatis, Microdontomerus anthonomi, Cerambycobius cyaniceps,* and *Cerambycobius n. sp.* *Bracon mellitor* is predominant in Texas except in the central and eastern portions. *Catolaccus incertus* appears as most important in south Texas and Louisiana. *Eurytoma tylodermatis* is at its best in north central Texas. *Microdontomerus anthonomi* is very important in central Texas. *Cerambycobius cyaniceps* predominates in northeast and east Texas and in northwestern Louisiana. The new species of *Cerambycobius* is known to occur only at Victoria, Hallettsville and Brownsville, Texas, and Alexandria, Louisiana. *Microdontomerus* is a new genus of the torymid sub-family *Monodontomerinæ* and furnishes the first species in that family known to attack Coleoptera. This species was new to science in 1906 and a very insignificant factor in the control of the boll weevil. In 1907 it appeared on places carefully watched in 1906 and where it was not found before and this year

became of real importance. The new species of *Cerambycobius* in the same manner is struggling upward for recognition. The rapidity with which these new parasites have adapted themselves to the boll weevil, together with the facts that parasite attack begins within two weeks of the invasion of new territory by the boll weevil, and that six new primary parasites were added to the list during 1907, has caused us to conclude that change of host relationships is not an uncommon thing in at least some groups of parasitic insects.

The peculiar distribution of the parasites and the appearance of new parasites each year, prove that the boll weevil is not the original host of any of them in this country. In other words, the parasites are all native insects and hence are derived from native hosts. With a few exceptions these native hosts are more or less closely related to the boll weevil. *Bracon mellitor* is recorded from three species of Lepidoptera and from seven species of *Curculionidæ*. *Catolaccus incertus* has been bred from two species of *Bruchidæ*, and thirteen species of *Curculionidæ*. *Eurytoma tylodermatis* has been bred from *Bruchidæ* and *Curculionidæ*. *Cerambycobius cyaniceps* is known as a common parasite of *Cerambycidæ*, *Bruchidæ*, and *Curculionidæ*. *Microdontomerus anthonomi* attacks one species each in the *Bruchidæ*, *Anthribidæ* and *Curculionidæ*. The new species of *Cerambycobius* also attacks species in these three families.

The presence of these parasites on neighboring weevils has afforded opportunity for an extensive study of weevil biologies in which over 125 weevil species have been more or less intimately studied. Some of these weevils have ranked as injurious species in literature and others of equal importance have never received economic mention. The study of the biologies and parasites of these species has produced several points of value, all of which will be published as rapidly as time permits.

From the standpoint of the boll weevil problem, it is of course essential that such an important point as the diversity of host relationships should be utilized economically. The first phase of this diversification is an adjustable rotation of hosts, which, of course, varies in consecutive years just as the variable climate affects the seasons, and as other conditions affect the abundance of the host plants. The parasites in the main attack weevils of few generations and consequently must have several species of hosts in a season. When a parasite matures, it evidently seeks as its host the most abundant related host species and attacks that. The boll weevil is the predominant weevil species in Texas and is therefore the recipient of all parasites in doubt, so to speak, about their next host. When the cotton is late,

it is necessary that there be from one to three generations of parasites on the spring weevils, thus producing a good supply of individuals at the time the boll weevil begins work. It is, however, best that the boll weevil receive the earliest generation possible in order to prevent a division with the other hosts. To insure the proximity of parasites to the cotton field in early spring, it appears advisable to have plants such as dewberry or blackberry in hedgerows, or to have red haw trees near. In the first case the strawberry weevil, *Anthonomus signatus*, is quite generally distributed and serves as an available host for *Catolaccus incertus*. The *Crataegus* trees are the food plants of three or four species of weevils which are co-hosts with the boll weevil.

During the summer season, there is an extensive series of host weevils in neighboring weeds which can be made to give up many parasites, if the weeds are cut when at their height, about twice during the summer season. The practice of making hay in the vicinity of cotton will bring about similar results. The principle is that the parasites will be forced to seek new hosts and will take the predominant related host—namely, the boll weevil. This is not a theory, for it is substantiated by definite experiments on the cotton farm at Dallas.

Adjacent to one edge of the Dallas experimental farm was a high hedge of *Ambrosia trifida* infested by *Lixus scrobicollis*, which is usually highly parasitized by *Eurytoma tylodermatis*. In 1906 this portion of the field showed less than three per cent parasitism due to this species in hanging squares. At the time of cutting the weeds, check examinations were made and two weeks later another was taken, showing a considerable gain in attack by *Eurytoma*, which netted over 30 per cent. The careful records kept on this field preclude the possibility of ascribing this result to any other cause.

In southern Texas where the predominant trees are leguminous, any cause which would tend to check the fruiting of the huisache and mesquite in alternate years or at irregular periods, would tend to cause an overthrow of the normal habits of the many parasites of the bruchids in the pods and drive them to the boll weevil. Our attention was forcibly called to a particular field at Victoria with high parasitism, where the presence of the new *Cerambycobius* on the boll weevil was first noticed and was definitely traced to the huisache trees which had failed to fruit this year.

The most important of all the cultural suggestions for control of the boll weevil is the early destruction of the cotton stalks. Owing to the probability that the parasites can hibernate better when attacking the native weevils, this practice seems advisable in order to drive the

parasites over to other hosts in time to insure their establishment. Having safely disposed of an important element of control and secured its reappearance, the stalks can be burned about fifteen days after cutting, thus establishing another important method of control. The total gain is greater than that to be had by allowing the parasites to hibernate on the boll weevil.

Finally there remains the third group of parasite methods, known as direct propagation, including the transfer of breeding material or parasites, the use of field cages for infested squares, and the establishment of new ant colonies.

After locating places where a very high percentage of parasitism prevails, either on the boll weevil or on other weevils, large quantities of infested material may be gathered and transported to the laboratory or to experimental fields where the parasites may be directly hibernated. In case of the existence of secondary parasites, the material must be placed in breeding cages in the laboratory. As this is a common practice, thoroughly understood by all entomologists, it need have no further treatment. It has proved of direct and immediate value when tried.

A similar method of treatment is at hand for all planters. They may gather infested cotton squares and place them in 14 to 18 mesh wire screen cages in the field with the assurance that all parasites and only a small portion of the weevils will escape, thus by a simple measure increasing the *pro rata* of parasites.

Since the little fire ants are very important enemies of the boll weevil, it is desirable to have some way of increasing their usefulness. It appears that they are very fond of fly larvæ in fresh manure and transfer their colonies to it frequently, and that by boxing this manure the colonies may be secured very easily. The method has not yet been tested. The time of swarming is the critical time for establishing colonies, for then a single queen is sufficient.

In conclusion it may be said that a decided gain is apparent in the amount of parasite control, that the cultural methods of cotton cultivation are most favorable to parasite propagation, that the host relations of the boll weevil parasites can be more or less easily changed, that immediate results have been obtained by the release of parasites, and finally that the present investigations are bringing to light evidence that must cause important modifications of some of the accepted ideas as to the host relationships of parasites.

The next paper presented was entitled:

THE CORRELATION BETWEEN HABITS AND STRUCTURAL CHARACTERS AMONG PARASITIC HYMENOPTERA

By Charles T. Brues, *Public Museum, Milwaukee, Wis.*

The problem of insect parasitism has always been a fascinating one from the standpoint of pure science, but during recent years it has become an increasingly important one for the economic entomologist. Indeed it has been discussed so fully and in so many aspects that I feel much hesitancy in adding the present remarks to the writings of many able entomologists better acquainted with the more or less heterogeneous mass of facts so far accumulated on the subject. My only desire is to present the matter in a somewhat different light.

The rapidity of increase among injurious insects which become introduced into new regions where they are not kept in check by their parasites was early noted and commented upon by entomologists, and certain experiences in our own country within the past few decades have brought out very clearly the fact that of all the forces which control the comparative abundance of related insects, the presence of their parasites is the most vital.

The balance maintained by the struggle for existence between species is immediately and violently disturbed if the parasites of any particular species be removed. Such a form suddenly begins to increase in numbers, reproducing itself at a phenomenal rate approaching the geometrical progression, which would theoretically obtain if every individual were permitted to reach maturity and reproduce itself. When the food supply is sufficient it will quickly become dominant over related species. Such conditions of rapid increase occur almost exclusively as the result of the introduction of an insect into a locality where its natural parasites do not occur, and are on this account most often brought to our notice by the rapid spread of injurious species.

Following the acceptance of this principle, was the attempt on the part of economic entomologists to combat accidentally introduced insects by purposely introducing the parasites which prey on them in their native region. The experiment has been tried a number of times under varied conditions and has proven almost universally successful in measure to warrant its trial whenever feasible.

There are vast numbers of parasitic insects, particularly Hymenoptera. These are widely distributed, and a very close relationship exists between allied species and genera inhabiting widely separated regions. It would be natural to suppose, therefore, that the transfer of an insect from one region into another would lay it open to attack

from some of the forms closely related to parasites which control it in its native environment. We have abundant proof however that such is not usually the case, and it is a matter of general agreement that the likelihood of any sudden variation appearing in the life history of a parasite, due to an introduced host, is very slight. Such a generalization is not universally true, especially among members of the dipterous family *Tachinidæ*, but seems to ordinarily apply, and does so particularly well, to the groups of parasitic Hymenoptera to which I shall confine most of my remarks.

Upon what, then, does this mutual adjustment between parasitic species and host species depend?

Entering the field of speculation, it is evident that there are a number of possible factors which may determine it, and I shall endeavor to consider the more important in turn.

That the physical form or size of a species has an important bearing on the matter of parasitism is undoubted. Parasites which live singly in the bodies of their hosts must necessarily confine their attacks to species which will furnish them with a proper amount of food to mature. On the other hand, it is imperative that the body of the host be entirely consumed at maturity in the case of parasites which pupate *in situ;* or in the case of species which leave the host for pupation, that the emergence of the delicate parasitic larva may proceed without accident.

Many of the smaller parasitic species, particularly certain *Chalcididæ*, may develop in large numbers within a single host. Such species ofter undergo remarkable multiplication during development, and the number of young is regulated to suit the food supply. The adaptability of certain forms in this respect has often been observed. For example, the well-known and widespread *Pteromalus puparum* attacks a considerable series of butterfly larvæ, ranging in size from rather small to large species, and the number of specimens derived from a single caterpillar is roughly proportionate to its size.

Such species are however decidedly in the minority, and within reasonable bounds, the size of an insect is a limiting factor in the determination of its parasites. This does not necessitate that all of its parasites be of uniform size, since the number of eggs laid in a single host usually determines the number of emerging parasites. For example, there may issue from a parasitized cocoon of the common Cecropia moth, but a single specimen of the large Ichneumon-fly, *Eremotylus macrurus*, while dozens of specimens of the small *Cryptus extrematatis* regularly issue from a single cocoon of the same moth. This sort of adjustment is almost universal, and most insects which have been

extensively studied are found to harbor parasitic species of each type. A similarity in form of body or type of structure is generally seen to exist between the hosts in cases where a parasite attacks several different insects. Thus all of the hosts of the aforementioned *Pteromalus* are caterpillars, and the same rule obtains among others, for example, among species of egg-parasites, which always attack insect eggs, although not always those of the same insect. Remarkable exceptions to this are nevertheless to be noted, for instance, the Chalcidid genus *Eupelmus* (*sensu lato*), which attacks both the eggs and larvæ of numerous species belonging to six natural orders of insects.

It is seen, however, that while the hosts of a given species, genus, or larger group are usually of similar form or habitus, that this similarity generally depends upon relationship and is not merely accidental, for we do not find ordinarily that insects presenting the same general appearance will have the same parasites. A species of *Ichneumon, I cyaneus* Cres., which attacks both saw-fly larvæ and caterpillars, is a notable exception.

In other words, dissimilarity seems to act more strongly as a deterrent than similarity does as a persuasive, in regulating parasitism.

Occurrence in a similar habitat acts very evidently in some cases to widen the range of hosts attacked. This is especially noticeable in the case of insects producing galls on plants. We must make allowance for the greater care with which the parasites of these insects have been studied, but it is nevertheless astonishing to see what a wide range of species are often regularly attacked by the same parasite.

The European Chalcid-fly, *Ormyrus tubulosus*, has been minutely studied by Mayr, who has bred it from no less than 27 species of Cynipid galls, and I have from Massachusetts what is apparently the same species, bred from about half as many North American species by the late Dr. M. T. Thompson. The galls formed by the various hosts of this species are many of them entirely dissimilar in form, the only resemblance between them, aside from their gross gall-like form, being their more or less uniform habitat, attached to twigs and leaves.

On the other hand, an isolated environment usually restricts greatly the possible parasites of a given species. A case in point is seen with species living beneath bark or boring into wood. Many groups are represented among the enemies of such insects, but all must come from groups provided with an elongated ovipositor, with which to reach the host for egg deposition. A beautiful case of complete restriction is the Ichneumonid genus *Thalessa*, which attacks certain wood-boring *Siricidæ*, deposting its eggs in the body of its host far within the infested tree by means of its enormously elongated ovipositor. It may perhaps

be urged that natural selection will develop a long ovipositor in any group where it may be of service, but the value of the elongated ovipositor for the separation of larger groups shows that it is an organ that is very slightly influenced by specific exigencies.

Seasonal distribution naturally limits the range of parasitism rather closely, since the time of appearance of insect species varies greatly; and as adult parasites are not long-lived, their hosts must appear at nearly the same time as they do themselves. The tendency is for parasitic species to undergo metamorphosis more rapidly than others, probably on account of their easily assimilated food, and with shorter life-cycle they will tend to pass through more generations in a season than their hosts in many instances. Here I believe lies the reason for the acquirement of more than a single host by some species, although it cannot explain the large number of hosts of some species, nor the several closely related hosts of others.

While some of the probable reasons for the association of host and parasite may be found among the foregoing, there seem to be no cases that can be fully elucidated by either one or a combination of all. Indeed, the very fact that there are so many closely related parasites and so little transfer to new hosts, would almost preclude such a supposition *a priori*, and some more subtle hereditary influence must be sought for.

Throughout the entire parasitic group, there are scattered here and there species which are particularly adaptive, in that they attack several or a number of more or less closely related hosts, while others not far removed taxonomically have apparently but a single one. But in nearly every minor group and in some of the larges ones, there is a well-marked tendency to select as hosts species belonging to another homogeneous group. Thus every one of the seven or eight hundred members of the Proctotrypid family *Scelionidæ*, so far as known, with one single exception of doubtful relationship, is an egg-parasite. Almost every species of the family *Alysiidæ* is parasitic on dipterous larvæ; practically all members of the extensive sub-family *Aphidiinæ* of the *Braconidæ* are aphid parasites, and so we might continue to list many more. There are here also very noticeable exceptions, but they only serve to show the strong tendency toward uniformity which exists everywhere.

Small groups do not always show the increased specialization which we might expect from the uniformity exhibited by so many larger groups, and species in particular may occasionally have almost as great a range in choice of hosts as genera or even larger groups. A case in point is the Chalcidid genus *Trichogramma*, which attacks the

eggs of insects belonging to four orders, one of its species, *T. pretiosa*, preying upon no less than 12 species belonging to two orders, the Lepidoptera and Hymenoptera.

It has often been customary among hymenopterists to assume that a different host species must almost surely have different parasites from those of a related form, even if sharp differential characters could not be observed, but reliance on this physiological character is gradually giving away to a demand for actual structural characters, and recent investigators place little confidence in host relations for the actual separation of species.

Undoubtedly the explanation for the fixity of habits throughout many of the larger groups, is the common inheritance of specific instincts through long periods of time without any, or with but little change, while the varied genera and species of the group have meanwhile been evolved. A habit thus formed has been handed down from generation to generation as the groups have passed into a more and more intricate interdependence, through the evolution of new species in each group. Such will be the natural trend of evolution, and we can readily comprehend how the habits of a group like the *Scelionidæ*, *Alysiidæ* or *Aphidiinæ* must have originated. The Alysiid are particularly interesting in this respect, as they form a very compact group distinguished from all its relatives with more than usual ease by a single morphological character, which does not allow of the different interpretations to which the characters of most other groups are subjected at the hands of the systematist. In cases where groups are more opinionative, habits themselves usually have considerable weight in the segregation of their components.

Conversely, that the variations from any uniform or related system are due to some sudden change in the nature of a mutation seems probable, and if so, the antiquity of the mutation should in some degree be traceable from a knowledge of the extent of the present variations.

Turning to view this possibility in the light of paleontological evidence, we find that several well-marked cases of unusually variable habits within a genus or small group are evidently associated with antiquity.

Among over one hundred undescribed species of fossil parasitic Hymenoptera, which I am working over from the Miocene shales of Florissant, Colorado, there are several genera that stand out distinctly on account of their abundance. One is the Ichneumonid genus *Pimpla*. It is represented by four or five species, one of which is the most abundant form in the entire collection. Evidently these were as dominant then as our species are at present. We find also that the recorded habits of *Pimpla* are unusually varied.

Another dominant genus resembles the present-day Chalcidid *Torymus* very closely, but on account of a somewhat less specialized wing venation, I have termed it *Palaeotorymus*. There are at least four distinct species from Florissant, represented by many specimens in the collection. Because of its evident antiquity it has had ample chance to give rise to variations in habits, through mutation or otherwise, and we find that the present species of *Torymus* are parasites of gall insects belonging to both the Diptera and Hymenoptera, and apparently of certain Coleoptera and Lepidoptera as well.

Chalcis (including *Smicra*, *Spilochalcis*, etc.) is another genus that is well represented at Florissant, and recent species of this dominant group attack insects belonging to at least three orders, Lepidoptera, Coleoptera, and Diptera.

That very persistent types are not always the ones to give rise to variations in habits is shown by the occurrence of many species of *Limneria*, *Ichneumon*, *Microgaster*, *Proctotrypes*, etc., in these same Miocene deposits. None of these particular genera seem to have at present a wide range of hosts.

Correlation between very slight characters and certain host relations is very common, and I shall mention one in closing. The genus *Telenomus* contains nearly 175 species of egg-parasites, and is distinguished from the closely allied *Phanurus* by such evanescent characters that many systematists recognize no generic division. Of the entire series only two are known to breed in the eggs of Diptera. Both attack the eggs of *Tabanus*, one in Europe and the other in America, while taxonomically they exhibit particularly well the slight differential characters of *Phanurus*, although they cannot satisfactorily be segregated from the rest of the genus upon a strictly morphological basis.

To judge, then, from the fragmentary evidence so far adduced, we can only suggest that the single explanation which seems applicable to the constancy of some groups and the variability of others, lies in the assumption of a general evolutionary trend toward gradual elaboration, broken here and there by a mutation in habits which has split off the progenitors of certain groups from the conservative majority. The fact that parasitism has undoubtedly originated independently in a number of groups further enlarges the possibilities of complexity in host relations.

A paper was presented as follows:

PRELIMINARY REPORT ON THE LIFE HISTORY OF THE CODLING MOTH AND SPRAYING EXPERIMENTS AGAINST IT

By E. Dwight Sanderson, *Durham, N. H.*

For the past three years we have been working on the life history of the codling moth in New Hampshire, and making experiments to determine the value of spraying at different times. The greater part of the life history work was done by Dr. T. J. Headlee or was under his immediate charge, as was also much of the field work.

It is convenient to commence the consideration of the life history of an insect with a discussion of its wintering habits and then follow it thru the season. Seven large apple trees were thoroly examined by a competent student last spring to determine the position in which the codling moth larvæ hibernate and their mortality. An average of 55 cocoons per tree were found, 70% being on the trunk and 30% on the limbs. Records showing the height of the cocoons on the trunk indicate clearly that more cocoons are to be found just below the crotch and just above the base of the tree, than are to be found midway on the trunk. It seems very evident that the larvæ descend from the limbs to the trunk and ascend from the dropped apples on the ground to the lower part of the trunk to form their cocoons. Eighty-seven per cent were killed by birds, 4% by fungus disease, 3% by cold, and but 5% remained alive. An examination of numerous other trees in the same orchard including the cocoons of 1,086 larvæ showed that 66% had been killed by birds, 9% by cold, 6% by fungus and 19% were alive. The percentage of mortality will of course vary with local conditions, but previous experience reinforces these observations that only a very small percentage survive hibernation.

In the spring a short tube is spun out from the cocoon prior to pupation. In 1906 the average date of pupation for 43 larvæ was May 25, the average length of the pupation stage 20 days, the majority of adults appearing about June 14. In 1907 the average date of pupation for 103 larvæ was June 16, the average length of the pupal stage being 16 days and the majority of adults appearing about July 2. It is interesting to note the difference of four days in the pupal stage in the two seasons. We have not studied the temperature data with sufficient care to determine whether the difference is due to temperature, but such a result shows the necessity for having a large series of individuals upon which to base our conclusions as to the life history of an insect, and also the importance of studying it for several years if its economic importance warrants it. The length of the pupal stage

varied from 3 to 64 days, those pupating earliest in the spring remaining the longest in that stage.

In 1906 the first moth appeared June 9 and in 1907 on June 13. In 1906 the last moth appeared June 26 and in 1907 on July 8. Thus there was a period of emergence of 17 days in 1906 and of 25 days in 1907. It is interesting to note the relation of these dates of emergence to the time of blooming of the apple. In 1906 the first moth appeared about ten days and the majority about 15 days after the petals dropped. In 1907 the first moth appeared about the time the petals dropped and the majority a little over two weeks later. Thus in 1907 the earliest eggs deposited would have hatched about ten days after the first spraying, while in 1906 they would not have hatched until three weeks after the first spraying. This will have an important bearing upon the effectiveness of the spray applied to the foliage and would possibly make it more effective one year than another.

Oviposition goes on for about a month, a female laying from 20 to 70 eggs, the average being about 50. The eggs we have observed hatched in 9 or 10 days. It is exceedingly difficult to get the female to oviposit. In 1906 we secured the record of seven moths, but in 1907 we were utterly unable to secure any oviposition tho the same methods were pursued. The eggs are laid on the upper or under surface of the leaves, only a fraction of 1% being laid on the fruit in this locality. An examination of about 700 eggs in the orchard shows that they are on the upper or under side of the leaves, but that on some varieties there are a large number on the upper side and on others more on the under surface. The average distance of 588 eggs from the nearest apples on three trees in 1907 was 6¼ inches, while the average distance from the nearest apples of 744 eggs on six trees during the past two years was nine inches, the average distance of eggs on each tree varying from 2 inches to 28 inches. Eggs are sometimes laid several feet from an apple and indeed are quite commonly laid upon trees with no fruit at all. An examination of a young tree bearing no fruit showed 31 eggs. Apples which are wormy do not seem to be any nearer to eggs than those which are non-wormy. A careful record of the nearest egg to the apples on several trees showed that the eggs were as near to those non-wormy as to those wormy. Very frequently the egg nearest a wormy apple has been 12 inches distant.

The young larvæ feed on the under surface of the leaves mining into the mid ribs and angles of the veins branching from the mid rib and into the axils of the leaves. We have succeeded in rearing a larva in a water sprout and securing the moth from it and several larvæ lived for some time upon tender water sprouts altho we have no evidence

that this occurs in nature. Feeding marks of the larvæ may, however, be readily found upon the foliage. It is evident therefore that the spray upon the foliage must affect the young larvæ. In 1906 eggs just ready to hatch were placed in the calices of apples and were bagged. Seven larvæ averaged 31.7 days in the apples. In 1907, similar experiments showed from 30 to 35 days spent in the apple, but the records were not as accurate. In 1906 no larvæ were observed to transform to pupæ and moths of the second brood during the summer, owing to the fact that the bands were not put on the trees earlier, but in 1907 pupæ were found under the bands, on August 8, the first moth emerging August 12 and moths continuing to emerge to August 23, in all 19 emerging, the most appearing on the former date. There was no increase in the number of larvæ under the bands at this time, but the number of larvæ found under the bands increases gradually from this time on. It is evident, therefore, that the first larvæ to mature transform to the second brood and it seems quite probable from a hasty study of the temperature records, that this is due to the fact that they are able to mature during the hottest part of the summer and that the later larvæ are not subject to so high temperatures. The number transforming and forming the second brood of moths is, however, exceedingly small, certainly not over 1% of the total.

We have been unable to secure very satisfactory data concerning the eggs of the second brood, but careful examination has failed to show them upon the apples. The second brood larvæ hibernate over winter and most of them can be readily detected by the small size and narrow head, but none of those partly grown transform in the spring. Whether a majority of the second brood mature in the fall is an open question. We have evidence that some of them undoubtedly do, but on the other hand we find a large number of the small hibernating larvæ which fail to transform in the spring.

In 1906 an elaborate spraying experiment conducted on 67 trees, there being 5 trees in each of 12 plots and 7 checks, practically failed to give any satisfactory results on account of the method in which the plots were laid out. The plots were arranged as shown in Fig. 3, the check trees being at one side of those sprayed. On either end of the sprayed plots were a few trees which had borne the previous year, but which were not in bearing in 1906. The Baldwin apple has a habit in New England of bearing every other year and all of the experiments here described were on Baldwins. As a result of the spraying, trees near those which had borne the previous year showed very much more injury by the first brood than those at the center of the sprayed plot more distant from them. As no barrier plot had been laid off

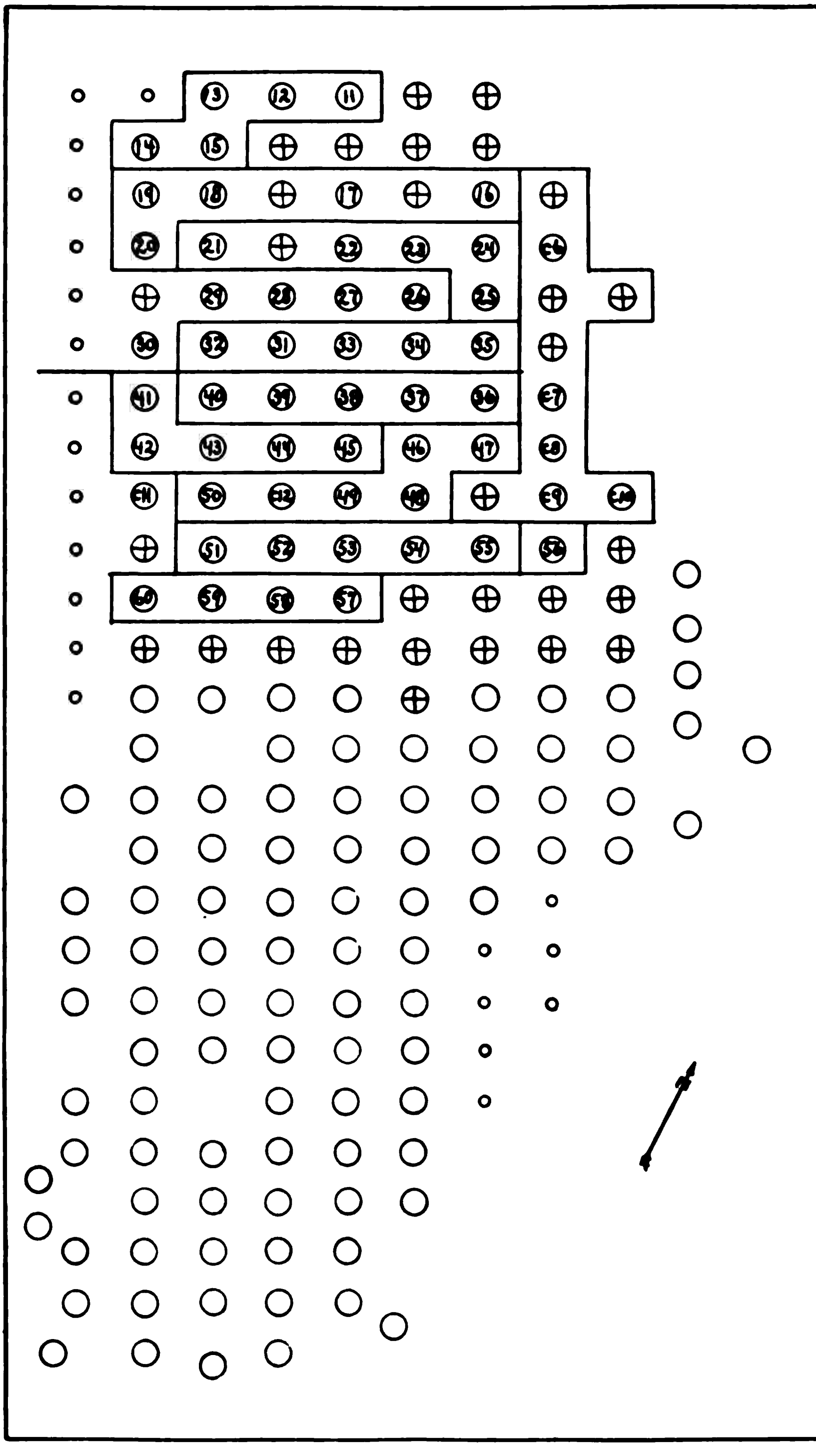

FIG. 8. Caption on opposite page.

between the check trees and the balance of the orchard, which was unsprayed, and the sprayed portion, the moths of the second brood migrated to the sprayed trees and those plots nearest the unsprayed portion showed very little benefit to the second brood, whereas the benefit increased with the distance from the unsprayed trees. The effect of these factors was very noticeable in studying the results. We then happened to remember Dr. Forbes' suggestive paper given before this association a few years ago, in which he showed the way in which the plum curculio migrated from the untreated part of the orchard into the part treated, and the necessity for leaving out of consideration a few rows of trees between the untreated and treated part of the orchard. We therefore decided that in making future experiments we would leave one end of the orchard unsprayed for checks, spray several rows across the orchard next to the checks in the best possible manner, calling this portion of the orchard the barrier plot, and would then lay off our plots at right angles to this barrier plot so that the influence of its effect upon the sprayed plots would be equal in all of them. Happily, at this time Prof. Quaintance and the writer met to discuss methods of work upon this subject, and it is to him that I am indebted for the suggestion that we make our plots three rows wide and count only the middle row, thus having 15 trees in each plot, the outer rows of which tend to reduce the influence of one plot on another. Our work this season has shown not only the absolute necessity for such an arrangement, but that it would be wise to go even further and have the plots contain 35 trees each, 5 rows wide and 7 rows long, and count the central five trees so as to better reduce the influence of the neighboring plots. It is of the utmost importance in making an experiment to give any exact results on the codling moth, that the trees be of a uniform size, fruit evenly, and have borne approximately the same the previous year. A few trees scattered thru an orchard which have borne the previous year when the balance of the orchard did not, will seriously affect the results of the work the following season. From careful study of our records, it seems to me that too much importance cannot be placed upon the ground plan of such an experiment, and I cannot but feel that experiments based on individual trees scattered thru an orchard are of little value in trying to determine the amount or nature of the effect of spraying upon the different broods of the codling moth. Furthermore at least five trees must be counted in each

FIG. 3. Diagram of orchard of Albert DeMerit, Durham, N. H., used in experiments of 1906. Circles represent trees. Circles with crosses are trees which bore in 1905, but bore practically no crop in 1906. Solid lines show boundaries of sprayed plots; remainder of orchard unsprayed.

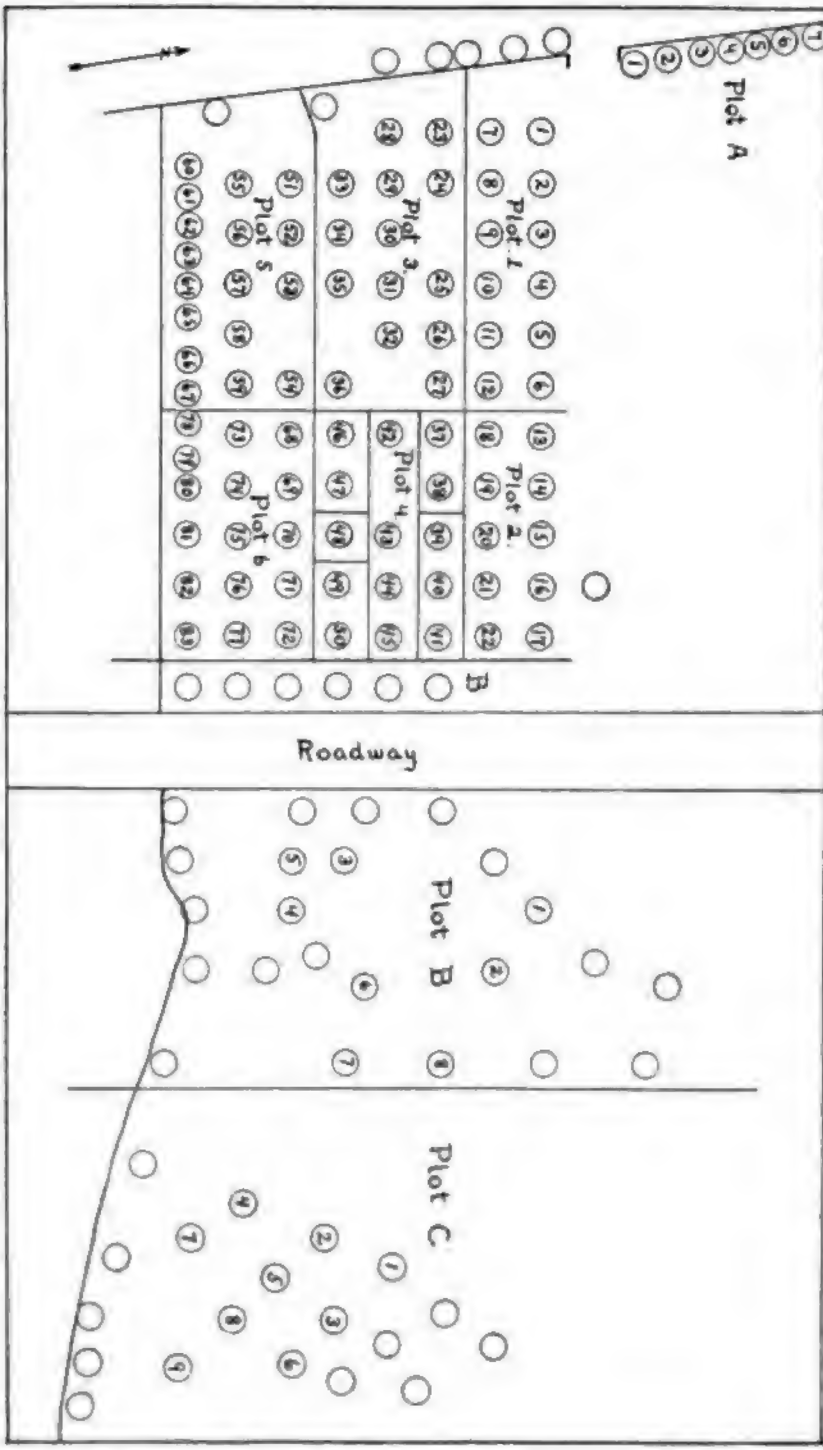

Fig. 4. Caption on opposite page.

plot isolated as already described by surrounding trees similarly treated, and preferably 10 trees should be counted, for it will be found that the records of five individual trees will vary fully as much as the average of one plot and another. All of these factors are therefore of the utmost importance and it becomes a considerable undertaking to make a careful experiment on this subject, the amount of the work depending very largely upon how much competent labor can be secured to make the records. It is needless to say that in our work every dropped and picked fruit has been examined and a record has been made as to whether it was wormy and whether the larva entered the calyx or the side.

It is not my purpose to give any extended discussion of the results of our work of this season, but to briefly report my conclusions. The full data upon which they are based will be published later. Fig. 4 shows the plan of the orchard.

The results of our work have been computed in percentages thruout. This is not the place to discuss our method of computing the results, but suffice it to say that after having compared the number of wormy apples to the number of apples on the tree and the percentage of wormy apples, we find that the percentage wormy is a much more reliable basis for comparison than the number of wormy apples themselves. Our conclusions are based on a study of detailed records of a total of about 400 trees, covering two seasons, and including a count of over 350,000 apples each year.

Plot 1 was given the third spraying (the third spraying being that immediately after the petals fall, the fourth spraying 10 days later and the fifth spraying about three weeks after the petals fall or when the eggs are hatching) with a fine mist. Plot 2 was sprayed at the same time with a Bordeaux nozzle and thoroly drenched, the spray being applied at 100 ℔. pressure. Neither of the plots were sprayed subsequently. This experiment was repeated under similar conditions in another orchard. There was but 2% or 3% difference in the result in both cases, in one orchard the result favoring the drenching and in the other favoring the mist, so that we are forced to the conclusion that there is very little difference in their effectiveness. Careful examination of the calices by Dr. Headlee failed to show any spray lodged beneath the stamens or in the calyx cavity proper, nor did he find any dead larvæ in the calyx cavity proper tho the results achieved by our spraying show very clearly that it was exceedingly effective.

FIG. 4. Diagram of orchard of Gilman Woodman, Durham, N. H., used in experiments of 1907. Plots A, 1, 2, 3, 4, 5, 6, experimental sprayed plots; plot 3, "barrier" plot; plot C, "check" plot, unsprayed.

We are therefore led to doubt whether in New England it is necessary to wait until the stamens have withered in order to force the spray beneath the stamens into the calyx cavity proper, as suggested by Dr. Ball last year.

Plots sprayed with paris green, one-third pound to the barrel and arsenate of lead, two pounds to the barrel, the insecticide being used with Bordeaux mixture, showed practically no difference in their effect. The addition of Bordeaux to arsenate of lead seems to decrease its value very little if any. The arsenate of lead and paris green have now been compared for two years, and where a sufficient amount of either is used, so that the percentage of arsenic is the same, one seems to be about as effective as the other.

The proportion of the larvæ entering the calyx has always been a matter of interest, as bearing directly upon the effectiveness of spraying into the calyx. We find for the first brood that the percentage of larvæ entering the calyx on unsprayed trees varies from 67% to 77%, in four orchards averaging 73%. For the second brood at Durham the proportion was 67% and 78% on unsprayed trees, averaging 74.5%, or practically the same as for the first brood, but at Pittsfield and Deerfield, back from the coast, and on hills, the second brood is smaller, as will be shown later, and but 22% to 24.6% of the second brood enter the calyx on unsprayed trees.

We have endeavored this year to determine the exact effect of the spray upon the larvæ, as to whether they are killed in the calyx, on the foliage, or on the surface of the apple, for both the first and second brood. Four trees were sprayed immediately after the blossoms fell with a hand atomizer, the spray being placed directly in the calyx without hitting the foliage. In all of these experiments the spray was arsenate of lead, two pounds to the barrel, without Bordeaux unless otherwise indicated. These four trees were not sprayed later. They gave a benefit of 59%, based on the percentage of the total fruit, which was wormy by the first brood, against a benefit of 91% on the plots which were sprayed in the ordinary manner so that the foliage was covered, indicating that about one-third of the benefit was due to the spray on the foliage.

One tree was not sprayed when the petals fell, but about three weeks later when the eggs were hatching. All of the apples on it were covered with paper bags and the tree was then thoroly sprayed, thus covering the foliage, but not the apples. The bags were then removed. It was contemplated to treat several trees in this manner, but as it was a week's labor to bag one tree, it was impossible. This spraying of the foliage gave only 18% benefit, based upon the percentage of the

total fruit wormy by the first brood, with 10% benefit due to less injury by worms entering the side of the apple, and the balance of 8% due to benefit by fewer worms entering the calyx.

One plot was given the fifth spraying (that is three weeks after the petals dropped, or as the eggs were hatching) in the ordinary manner, in this the apples being sprayed as well as the foliage, but not having been previously sprayed, no poison was deposited in the calyx. This plot gave a benefit of 25%, based on the percentage of the total fruit wormy by the first brood, with a benefit of 15.7% due to fewer worms entering the calyx, and 9% due to fewer worms entering the side. If the benefit derived from spraying the foliage only upon the tree, which was bagged, be subtracted from that secured on the plot where both the foliage and apples were sprayed with the fifth spraying, we get the benefit due to the spray on the apples as regards the first brood, and find that it is about one-fourth of the value of this fifth spraying, and consists entirely of a benefit due to fewer worms entering the calyx or about 7%. If we divide the value of the fifth spray between the benefit derived from fewer worms entering the calyx and fewer worms entering the side, according to these proportions, we find that 9% out of the 25% is due to fewer worms entering the calyx and 15.7% due to fewer worms entering the side, or about two-fifths of the benefit is due to the calyx and three-fifths to the side.

But only 29% of wormy fruit are due to the work of the first brood on the unsprayed trees. When the benefit done by the control of the first brood alone is measured in terms of percentage of the benefit for the whole season, we find that only 27.5% out of 96% is due to the direct benefit on the first brood, where sprays III, IV and V were given. As a matter of fact the benefit of these sprayings thru their effect on the first brood is much greater than this and can only be shown after we have considered their effect on the second brood.

The addition of spray V did not seem to materially increase the benefit to the first brood when given after spray III, but the addition of spray IV and V to III show a very slight benefit over III and V.

In order to determine the true benefit of the effect of sprays on the first brood, we must find their effect on the second brood and by subtracting it from the total effect for the season we secure the real benefit due to the influence on the first brood, for it is evident that by reducing the numbers of the first brood there will be fewer of the second brood, and the apparent total benefit to the second brood is therefore really due to the effect of the lessened numbers due to the killing of the first brood, as well as to the direct effect of the spray upon the second brood.

The proportion of apples injured by the first and second brood varies with the locality and seemingly according to the percentage which transform to the second brood. Thus, at Durham in 1907, 29% of the wormy apples were injured by the first brood and 71% by the second, and in 1906 about 40% were injured by the first brood and about 60% by the second on unsprayed trees, while at Deerfield, 15 miles distant in the hills, in 1907, 70% were injured by the first brood and 30% by the second brood, and at Pittsfield, 30 miles distant, 48% were injured by the first brood and 52% by the second brood on unsprayed trees.

The effectiveness of the spraying seems to vary somewhat from season to season, and it seems quite possible that if heavy rains follow sprays III and IV that their effect upon the larvæ feeding upon the foliage would be lessened, whereas the benefit due to spray V would not be so much affected as if it is applied just as the eggs are hatching. Those plots sprayed with only the third spraying show but little total benefit to the second brood, averaging 12%, while those sprayed with the third and fifth sprayings show little or no total benefit, due probably to the fact that the destruction of the first brood was so complete that it is very difficult to determine any additional influence, unmistakably due to the effect of the spray on the second brood. But an addition of spray VI (spray VI being applied when the second brood of eggs are laid) gave 70% of the possible benefit due to the direct effect of the spray on the second brood. Spray IV gave a total of 22% of possible benefit, and spray V from 22% to 79% of possible benefit, with an average of 60% of the possible benefit due to the direct effect of the spray on the second brood, this being 22% benefit in terms of the benefit for the whole season, which was but 58%, or in other words 37% of the total benefit of the year was due to the direct effect of spray V upon the second brood.

Analyzing this benefit to the second brood, as to its effect upon the worms entering the calyx and side, we find that in the plot treated with spray III the benefit to the second brood was due entirely to those entering the calyx, giving 46% benefit to the calyx, but showing a loss of 14% or 15% in those entering the side, thus indicating that some of the spray lodged in the calyx affects the second brood which enter the calyx, but that the third spray has no effect on those entering the side, or in other words, kills very few or none of the second brood upon the foliage. When spray V or IV and V are added to spray III, from 75% to 80% benefit to the calyx is secured, but no benefit is secured to the side, but with the addition of spray V and VI (VI being applied for the second brood eggs), 95% benefit to the

calyx and 25% benefit to the side for the second brood is secured, showing that spray VI kills mostly by its effect on larvæ feeding on the foliage. That no benefit is secured in lessening the number of worms of the second brood entering the side when spray V is added to spray III as would be expected from the additional spray put on the foliage, is doubtless due to the very effective work on the first brood of sprays III and V, leaving such a small percentage to be killed by the direct effect of the spray on the second brood as to be undemonstrable.

Spray V alone gave an average of 66% benefit thru lessening the worms of the second brood entering the calyx, and was the only one showing any benefit by lessening the worms of the second brood entering the side, giving 62% benefit to the side, the benefit to the side and calyx being practically equal tho twice as many worms entered the calyx as the side in the checks, thus showing that 66% of the second brood which entered the calyx are killed by spray on the foliage, as well as 62% of those which would enter the side. Thus about 60% of the benefit possible to secure from the direct effect of the spray upon the second brood is secured by the fifth spray alone applied to the foliage, and this spray would therefore be of importance in an orchard adjoining an unsprayed orchard near enough for the second brood of moths to spread to it. This is shown by our barrier plot, "B", which showed a total of 20% of the possible benefit due to direct effect on the second brood, while plot 3 surrounded by sprayed trees showed no such benefit. Furthermore the tree on which the apples were bagged and only the foliage sprayed with the fifth spraying, shows as much total benefit to the second brood as those in which the apples also were sprayed at the fifth spraying, again showing that most of the benefit due to the direct effect on the second brood is from the effect of the spray on the foliage.

Considering the part of the total benefit of the season which is due to the spray affecting the first brood as against the second brood, we find that in case of spray III, and III and V, that 88% to 100% of the total benefit was due to the effect on the first brood and thru it to the second brood, whereas in spray V only from 36% to 86% (average 64%) was due to the effect on the first brood, and from 14% to 64% of the total benefit was due to its effect on the second brood.

Thus in New England the first brood may be controlled by thoro spraying at the time the petals drop, spray III, but if there be danger of the second brood migrating into the orchard, spray V should always be added, as it will sufficiently control the second brood, tho if an infestation be serious in neighboring orchards, the sixth spraying will

sometimes pay in addition. In New England the fifth spray should always be used with Bordeaux mixture for the control of the fruit spot irrespective of the codling moth, so that the addition of arsenate of lead will cost but little and will render the control of the codling moth much more certain. Early in August it is well to spray for the brown-tail moth and other leaf-eating caterpillars, which have been quite numerous in New England orchards for the last few years, and the sixth spraying will therefore control them and the second brood at the same time.

Considering the total benefits for the season, it is found that spraying the calyx only may give a benefit of 62%, while spraying the foliage only may benefit 52% (tho the influence of adjoining treated plots increased the benefit by decreasing the second brood of these plots, so that really the benefit is less), but where foliage and apples are sprayed at the fifth spraying, a benefit of 74% may sometimes be secured, tho here again neighboring plots have increased this apparent benefit.

Whether the spray on the foliage or the spray on the calyx kills the more larvæ, it is impossible to determine definitely from our results, which would seem to indicate that where spray V is given there are about two chances that a larva will be killed on the foliage to three that it will die in the calyx. Giving our figures as conservative an interpretation as possible, it would appear that of the total benefit for the whole season, at least one-third and possibly one-half is due to the spray on the foliage, and the balance to that deposited in the calyx. Heretofore only the spraying of the calyx has been emphasized, but in all cases where records have shown a separation of the apples wormy in the calyx and in the side, such as those given by Dr. Ball at our last meeting, a decided benefit has been shown by reducing the number of larvæ entering the side, and if this be due to the spray deposited on the foliage, how much of the apparent benefit from the decreased number of worms entering the calyx is really due to their being killed on the foliage?

Mr. Taft stated that in Michigan it is necessary to apply an extra spraying to control the second brood of this insect.

Mr. Fletcher asked if it is not probable that New Hampshire and Michigan are in two different faunal areas, as far as the codling moth is concerned.

Mr. Taylor was positive that the results given in this paper would not apply in Colorado. He recalled experiments and observations which had extended over fully five hundred acres of orchards where

the first generation was practically controlled. Possibly the larvæ feed on the leaves to a greater extent in New Hampshire than in Colorado. In Grand Valley in Colorado in 1907, the entomologist kept track of the climatic conditions and the growers were notified by circulars, telephone or telegraph, so that the spraying was done at exactly the right time. The results that were secured in Colorado agreed in general with those of Dr. Ball in Utah.

Mr. Headlee stated that the apple crop was an absolute failure this year in Kansas and asked if there would be codling moths next year. In reply Mr. Quaintance said that the moth was supposed to have been exterminated in a small valley in California in this manner. Professor Garcia is now conducting an experiment of this kind in New Mexico.

Mr. J. B. Smith called attention to the fact that the pupae of Lepidopterous insects that are normally single brooded sometimes pass the winter in that stage. If this was occasionally the case with the codling moth, the species might be carried over in this way.

Mr. Taylor mentioned the entire absence of codling moth eggs in orchards that were barren in 1907, though badly infested in 1906, when a full crop of fruit was borne.

Mr. Fletcher remarked that he had once carried this insect over the second winter in the pupa form, but the specimen was kept in his office.

Mr. Quaintance presented the following paper:

NOTES ON THE LESSER APPLE WORM, ENARMONIA PRUNIVORA WALSH

By A. L. Quaintance, *Washington, D. C.*

(Withdrawn for publication elsewhere.)

Mr. Sanderson asked if the work of this insect can be distinguished from that of the codling moth larva. Mr. Quaintance replied that the larvæ work to a considerable extent in the calyx basin, boring holes into the flesh from one fourth to one-half an inch deep around the calyx and eating out the flesh under the skin in the calyx cavity; and also on the sides of the fruit, especially where touched by another apple or a leaf. Except as the fruit is nearly ripe, larvæ rarely penetrate to the seeds, as is done by the codling moth larvæ. The lesser apple worm, when full grown, is about the size of a half grown codling moth larva, but is somewhat fusiform in shape and is flesh-colored, or pinkish. On the caudal portion of the anal segment there is a small

brownish comb-like structure composed of seven teeth and distinguishable with a hand lens.

Mr. Bruner stated that he had found an insect which he had supposed to be this species of *Enarmonia* on wild roses.

A paper was presented, entitled:

EGG LAYING OF EMPOASCA MALI

By F. L. WASHBURN, *St. Anthony Park, Minn.*

In the twenty-first annual report of the state entomologist of Illinois (1900), Professor Forbes states that what were then supposed to be the eggs of the above species were found in slight swellings on the green twigs and on the mid-rib and leaf stem of the apple. This supposition regarding the summer egg must have been correct, for we find young larvæ so small and helpless on the mid-rib during the summer as to force one to conclude that its place of hatching must have been near by. Nevertheless, the truthfulness of the supposition was not determined at that time, and so far as we are able to discover, there has been, up to this date, no absolute confirmation of this belief, nor has there been, to the best of our knowledge, at any time hitherto, any accurate observations on the location of the fall-laid eggs, the eggs from which come the first spring brood.

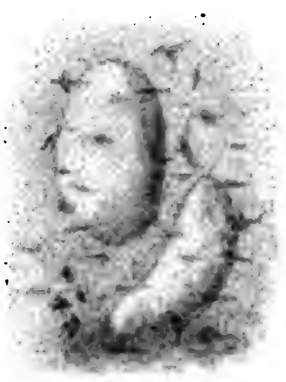

FIG. 5. Blisters containing eggs of *Empoasca mali*, much enlarged (original).

Young apple trees which had been infested with leaf hoppers in the summer of 1906 were dug in October of the same year and planted in the insectary at the Minnesota Experiment Station. The heat was not turned on in the room until quite late in the winter. The leafing out of the trees was shortly followed by the appearance of *Empoasca* larvæ, but in spite of careful searching, eggs were not discovered. Later in the spring, however, when hoppers appeared outside, Mr. Ainslie, at that time an assistant in the department, found, April 23d, on a young apple tree back of the insectary, several pouches or pockets in the bark about 2 mm. long and 1 mm. wide at their widest portion. The mouth of each pouch was about 1 mm. long. This opening appeared to be closed with dirt or woody growth. One was dissected and found to contain an egg which almost filled the pouch, its small end toward the opening. Mr. Ainslie describes the egg as being white

with a membranous and semi-opaque shell, and 1.5 mm. long. He says in his report: "The cavity was lined with a reddish, glossy material, which seemed to be a thin skin, separable from the woody tissues. The sap was just beginning to run and the tissues were full of it."

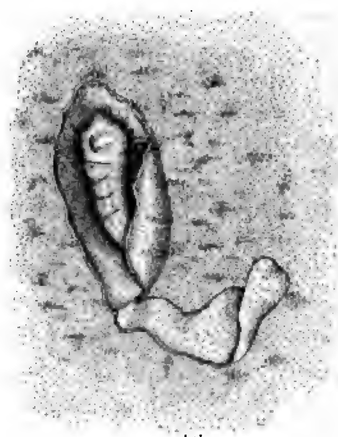

Fig. 6. Nymph of *Empoasca mali* within the pouch, the covering epidermis being turned back, much enlarged (original).

Of course, it yet remained to be proven that the above egg was that of *Empoasca*. No more eggs were found until May 24th, when Mr. R. L. Webster, in charge of the insectary and a part of the field work for the department during the summer, found them quite numerous in three-year old apple stock in a southern Minnesota nursery. He reports these eggs as being somewhat smaller than those found at St. Anthony Park, measuring .4 and .75 mm. Mr. Ainslee's description applies so well to the later found eggs that there is but little if any doubt of their being those of the same species. All these "blisters" or pouches containing eggs were found on old wood in the upper part of the trunk, and none on the small twigs, and their general shape varied from that of a fresh water mussel or clam shell to almost cylindrical.

A small tree showing a number of these blisters was taken into the insectary, and there a young *Empoasca* was observed in the act of emerging. This specimen died before becoming free from the blister. A sketch was made at the time by our artist, showing the bark cut back and the body of the larva below.

We cannot speak of the location of the summer egg with as much certainty as we can of the winter egg, although putting the evidence in our possession with that of others, we are inclined to the belief that the petiole and mid-rib, as well as the leaf itself, may be the places chosen for oviposition on the apple by the females of the summer generations, for Ainslie found on June 25th an enlargement on a petiole which contained the remnant of an egg shell, and on September 4th Webster found a swelling in a leaf similar to that which characterized the presence of the winter eggs. Only one was found. Webster describes it as 5 mm. long, slightly brown, with a slit in one end.

On September 19th in a large nursery, Mr. Ainslie examined a number of one year old apple trees. These trees were almost hidden in a

growth of buckwheat planted for winter protection. The plot had been infested with leaf hoppers earlier in the season, and a few were doubt of their being those of the same species.

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The buckwheat growing amongst these trees was also examined, and two similar discolored swellings found on petioles. At this date there were very few *Empoasca* on the trees, but they were numerous on the buckwheat. Dissection of some of this material on November 9, preserved in alcohol since September 19, and not in very good shape, disclosed nothing of which we can speak definitely.

Insectary records of the stages of *Empoasca* show a record of from nineteen to twenty-five days as nymphs, and five nymphal stages between egg and adult. It was practically impossible for us to determine the length of each instar exactly, but it may be safely said that the first brood nymphs have longer instars than those in the following broods. The average lengths of individuals in the successive nymphal stages are as follows: First stage, .8mm.; second, 1.3 mm.; third, 1.7 mm.; fourth, 2.1 mm.; fifth, 2.4 mm., and the adult 3.1 mm.

Mr. Webster reports observing these hoppers hopping in the last nymphal stage, in several instances leaping a distance of over a foot.

These observations were made in the field at a time when the hoppers were disturbed. From this observation it would seem that while they always walk in the first, second, third and fourth nymphal stages, they may either walk or hop in the fifth.

Evening Session, Saturday, December 28, 1907

The final session of the meeting was held in the parlors of the Windsor-Clifton Hotel at 8 p. m.

The following papers were presented, the discussion being postponed until the close of the last paper:

NOTES ON SOME INSECTS OF THE SEASON

By Herbert Osborn, *Columbus, Ohio.*

While there has been no widespread devastation from insects during the past season in Ohio, there have been several minor outbreaks covering certain localities, and some of these it seems worth while to put on record. Comparison of these with occurrences of these species or of other forms during other seasons has a distinct interest.

In the northern part of the state there was a quite noticeable amount of injury from the bollworm, *Heliothis obsoleta.* This was particularly serious in gardens and on the truck farms in the vicinity of Sandusky, and in addition to the ordinary attacks upon corn and tomatoes, attacks were made upon nearly all kinds of garden crops. Very noticeable injury occurred upon beans, cabbages and various other crops that have not been so commonly attacked.

In the vicinity of Columbus there was considerable damage by the walnut caterpillar, *Datana angusii,* many trees in Columbus and vicinity being stripped completely bare of foliage, and clusters of *Datana* occurring, sometimes representing a half dozen or more colonies upon a single tree.

Another species that was unusually injurious in the central part of the state and I think over a considerable area is the white-marked tussock moth, *Hemerocampa leucostigma.* These occurred in immense numbers upon maple trees and also on other kinds of shade trees, and the egg clusters on the cocoons have been a very conspicuous object during autumn and the present winter.

ENTOMOLOGICAL NOTES FROM MARYLAND

By G. P. Welden, *College Park, Md.*

(Read by T. B. Symons.)

Scale insects, though still holding a place of importance in the state, are no longer dreaded, as formerly. A large percentage of the fruit

growers are successfully controlling the ravages of these pests, and it is only a question of time until a few negligent people in isolated localities will hear of the good work being accomplished and will fall into line with the host of successful combatants. Time will bring about a wide enough dissemination of knowledge, so that scale will be practically eliminated from all orchards where it occurs through the use of a good spraying mixture, properly applied.

Aspidiotus perniciosus is without doubt the most generally distributed scale pest occurring in the state. Others that deserve more than passing mention are *Eulecanium nigrofasciatum, Chionaspis furfura, Lepidosaphes ulmi* and *Chrysomphalus tenebricosus.*

Chrysomphalus tenebricosus. The past season was especially favorable to the increase of this species, and in many parts of the state the native maple trees suffered severely from its attack. The natural parasites which usually occur in large enough numbers to keep it in check seemed in many places to be exceedingly scarce, which fact no doubt accounts for the severe damage done by the scale. From the fact that no trees in badly infested localities were found to have been killed outright, it is probable that the multiplicity of the pest the past season was unusual. Many trees were literally coated with the scale and cannot possibly survive another season's attack, should it continue to breed in such large numbers, unless the owners of trees come to their aid with the lime and sulphur wash or some other good insecticide. Though no trees were found killed by the pest, the numerous dead branches told of its ravages and foretold the destruction of the trees.

The distribution of the pest seems to be quite general throughout the state. It was found on red maples *(Acer rubrum)* in Cumberland but not in destructive numbers. The worst infested section lies east of the bay, and of the counties visited, Talbott, Worcester and Somerset have the greatest degree of infestation.

No insecticides have been tested for its control, but from the nature of the scale and its attack we would feel safe in recommending the lime and sulphur wash as a good remedy.

Lepidosaphes ulmi. This pest and *C. tenebricosus* are the two most important enemies of maple trees in Maryland. The oyster shell scale has been so frequent a subject for discussion that we do not wish to go into any lengthy history of its occurrence and ravages within the state. We do wish, however, to mention one thing that came to our notice upon investigating its injury in different parts of the state the past summer, and that is the seeming immunity of Norway maples to its attack. Only in one case did we find *Lepidosaphes ulmi* on Norway

maples and that was on a few small trees in a nursery row. This immunity, or probably we might better say resistance, was particularly noticeable in Cumberland, where the scale was exceedingly bad on poplars and native maples. Apparently none of them were absolutely free from it, yet Norway maples, which are very plentiful in the city and growing alongside of them, were examined in large numbers, and not in a single case did we find one infested.

Further investigations might prove the fallacy of the above statements, but we think it probable that there is a resistance here at least as great as that of the Kieffer pear to *Aspidiotus perniciosus*.

Monocesta coryli. Among the insects of less common occurrence which became a pest in at least one locality in the state the past season, may be mentioned *Monocesta coryli*, the greater elm leaf beetle. This beetle was found in large numbers last July in the vicinity of Keedysville. Its attack seemed to be confined to the native wild elms, which it was defoliating so badly that it would no doubt be a serious pest, should it continue to appear in future seasons as it did the past.

We were unable to find any literature indicating its presence in the state prior to the past season. One specimen in the department collection, however, bears a Sharpsburg label, dated July 21, '98. No notes could be found which would indicate that it had occurred there in large numbers at that time. As the present year they were found within a couple of miles of Sharpsburg, it seems reasonable to believe that they have been in the vicinity for a number of years, but probably in less numbers. In the Mississippi Station report for 1895, Mr. H. E. Weed mentions its presence in that state and suggests for it the name of Greater Elm Leaf Beetle to distinguish it from the more common smaller species of elm leaf beetle, *Galerucella luteola*.

Owing to the fact that *Monocesta coryli* is of uncommon occurrence and is not a familiar insect to many workers in entomology, we thought best to publish herewith a short general description of same.

The full-grown adult insect is about one half inch long from the anterior margin of head to the posterior margin of elytra. Head, legs and abdomen are a light yellow color. Anterior one third of the elytra and a trifle more than the posterior one third, are of a deep green color shading on blue, with a beautiful metallic luster. A wide band of yellow crosses the elytra between the green markings. Elytra are long, projecting well back of the tip of the abdomen, also well below the sides. There is much in the general appearance of this insect to indicate that it is a tropical species which has migrated north, and has become acclimated in this latitude.

No remedies were tried for its control, neither were we able to

learn anything of its life history, as a number placed in a breeding cage failed to breed in confinement.

Monoptilota nubilella. On July 16 a number of lima bean plants, upon the stems of which were numerous galls, were sent to the department by Mr. Oscar L. Moore of Salisbury. They varied in length from ½ inch to 1½ inches. An opening had been made by the larvæ in one end. Upon cutting into one of these galls, a beautiful bluish green larva was found to be responsible for their formation and the subsequent injury to the plants. The larva is a striking one in appearance, because of its uncommon metallic blue reflections. Several of the adults emerged from the galls and were identified as *Monoptilota nubilella.* A detailed account of this insect by Doctor Chittenden of the Bureau of Entomology may be found in Bulletin 23, new series, U. S. Department of Agriculture.

This pest was first found in the state in 1899 and has no doubt been responsible for more or less injury to lima bean plants since that time. No serious complaints of its injury came to the office, but should it become plentiful, it would no doubt be a hard pest to combat. The only means of control suggesting itself would be the removal of the galls from infested plants.

Thyridopteryx ephemeraeformis. This species of bag worm was responsible for a large amount of injury to fruit and shade trees the past season. Numerous inquiries as to its name and habits were received from widely separated localities in the state, showing that its occurrence was general. In many different places the writer saw evergreen trees, mostly arbor vitae in hedges, killed by it. Its attack was by no means confined to evergreens, however, for it was found on locust, blackberry, rose, maple, apple, plum and cherry. Young fruit trees seemed especially subject to its attack and trees in several young orchards visited were badly stripped.

Other pests of the season which were responsible for more or less damage but deserve no more than passing mention were: Army worm *(Heliophila unipuncta)*, old-fashioned potato beetle *(Epicauta vittata)*, bean leaf beetle *(Ceratoma trifurcata)*, striped cucumber beetle *(Diabrotica vittata)*, stalk borer *(Hydroecia nitela)*, red humped apple worm *(Schizura concinna)*, yellow-necked caterpillar *(Datana ministra)*, and corn bill bugs *(Sphenophorus sp.)*.

ENTOMOLOGICAL NOTES FOR 1907

By E. P. Felt, *Albany, N. Y.*

The climatic conditions of 1907 departed widely from those of normal years, and as a result the development of animal and plant life

was exceptionally late. Warm weather finally came on very rapidly and all vegetation grew at such a rate that insects appeared unable to inflict material damage in many cases, consequently there has been a remarkable dearth of injurious outbreaks, particularly in the early part of the year and presumably largely due to this cause.

The San José scale, *Aspidiotus perniciosus* Comst., continues to be one of our most serious insect pests. It is gratifying to state that a number of our more progressive fruit growers at least have learned to control this insect in a very satisfactory manner. There is a strong tendency on the part of many to adhere to a lime-sulphur wash rather than to make extensive treatments with mineral oils or preparations of the same, despite the fact that some of these last named materials have been pushed vigorously by certain commercial agencies. The backward season had a very pronounced effect on the development of the grape root worm, *Fidia viticida* Walsh. Normally, this species transforms to the pupa from about June 1st to the 20th, the full grown larvæ being near the surface some days at least before pupation occurs. Observations made July 10 resulted in finding only a few recently transformed pupæ on light soil, whereas under normal conditions the beetles would have appeared two or three weeks earlier. There has been on the whole a distinct improvement in conditions over those obtaining a few years past, though it should be borne in mind that there is always danger of serious injury by this pest in restricted areas. The apple leaf folder, *Ancylus nubeculana* Clem. is normally rare in New York state orchards. It was so abundant in Cattaraugus County last September as to lead to the report that it was doing considerable damage to apple trees in that vicinity.

Our attention was called the last of July to the unusual abundance of a comparatively unknown form, namely, *Epizeuxis denticularis* Harvey. This species was so abundant at Palenville, Greene County, N. Y., that hundreds were observed upon the walls of the kitchen and they were also very numerous about the barn and other out-buildings. It is very probable, considering that the larva of the closely related *E. lubricalis* Geyer feeds upon grass, that the caterpillar of this species may have similar habits, though it is possible that it may subsist upon dried vegetation, as has been recorded of *E. aemula* Hübn. The evidence at hand would seem to favor the latter conclusion, as the moths were very abundant in buildings where there was presumably a goodly supply of dried provender upon which the caterpillars could subsist. Should such prove to be the case, this species should be classed with the much better known clover-hay worm, *Hypsopygia costalis* Fab. as a species liable to injure stored hay.

Several shade tree pests have excited considerable interest because of their serious depredations. The white marked tussock moth, *Hemerocampa leucostigma* Sm. & Abb., defoliated trees in a number of cities and villages in New York state, and would undoubtedly have caused more injury had it not been checked by local work in various communities. The elm leaf beetle, *Galerucella luteola* Müll., was exceedingly destructive to the elms of Albany and Troy in 1906. An extended injury in 1907 was prevented only by thorough and extensive spraying. The sugar maple borer, *Plagionotus speciosus* Say must be ranked as one of our most injurious species, as observations show that it is seriously injuring young maples here and there throughout the state. It is abundant enough in some localities to threaten the existence of long rows of nice young trees.

Forest insects have occasioned considerable anxiety in certain parts of the state. The green striped maple worm, *Anisota rubicunda* Fabr., was very abundant over several square miles of forest land in southern Rensselaer County, defoliating tracts of sugar maples acres in extent. The operations of this insect were first observed in 1906, at which time approximately eight or ten acres were badly injured. The past season these trees were entirely stripped of foliage, and maples here and there over a considerable area lost a goodly proportion of their leaves. This species was assisted in its destructive work by what we have designated as the antlered maple caterpillar, *Heterocampa guttivitta* Walk., a species which was evidently very numerous, judging from the specimens submitted for examination. Certain of the beech forests in the Catskills suffered from an outbreak by the snow-white linden moth, *Ennomos subsignarius* Hübn., the caterpillars being numerous enough to strip most of the trees over an area about a mile long and ranging from one eighth to one fourth of a mile in width. An unusual injury was the destruction of some 2,500 to 3,000 one and two year old white and Scotch pine seedlings in the state nurseries located in the Adirondacks. The injury, so far as observations could be determined, was caused entirely by white grubs, presumably those of our common northern form, *Lachnosterna fusca* Fröhl.

A BRIEF SUMMARY OF THE MORE IMPORTANT INJURIOUS INSECTS OF LOUISIANA

By Wilmon Newell and Arthur H. Rosenfeld, *Baton Rouge, La.*

Louisiana, with her combination of semi-tropical and temperate climates and plants and the consequent variety of natural enemies of the latter, is of great interest entomologically. For many years ships from foreign countries have been entering the port of New Orleans,

bringing with them much of the flora and fauna of tropical and other countries. Until very recently nothing has been done to prevent the dissemination of all kinds of new and dangerous insects to all parts of the state from New Orleans as the main entrance point. As a result the insect enemies of plants and animals in the Pelican state are legion.

The authors have not attempted in this paper to catalogue all of the injurious insects of the state, but as there has been no report of this kind presented from Louisiana for several years, they have thought it well to place on record a brief account of the most injurious insects which have come to their attention during the past three years.

The economic importance of a species is determined by the value of the plants or animals which it infests. The codling moth, for example, a most important pest in the North, is of no importance in Louisiana, simply because the apple crop is not of commercial size. The injurious insects of Louisiana therefore take a different rank, in the order of their importance, than in most other states. It may be well to mention that the cotton and sugar-cane crops of Louisiana far excel in value any of her other products, each of these crops being worth in the neighborhood of $26,000,000 annually. The yearbook of the Department of Agriculture for 1905 gives the value of several of Louisiana's other important crops as follows:

Corn	$11,905,064
Rice	5,511,730
Hay	568,353
Potatoes	532,663
Oats	199,548

Besides the above Louisiana has important nursery and orchard interests and the value of her output of live stock is by no means small.

Cotton Insects

Louisiana's cotton pest of greatest importance is, of course, the boll weevil, *Anthonomus grandis* Boh. The state has an area of about 45,000 square miles, of which approximately three fourths, or 34,000 square miles, is embraced in the cotton-growing area. Of this, about 29,000 squares miles are now infested. About 15,000 square miles are heavily infested, while in the remaining 14,000 the infestation is still slight. Enough is already on record regarding this insect to render further mention unnecessary.

The boll worm, *Heliothis obsoleta* Fab., has varied in its attacks with the seasons. The past year the boll worm ravages have been particularly severe, and much of the injury by this pest was ascribed by planters to the boll weevil.

The attacks of the cotton caterpillar, *Alabama argillacea* Hübn., the cotton aphis, *Aphis gossypii* Glover, and the cotton square-borer, *Uranotes melinus* Hübn., have been generally variable, but seldom severe. Late in the season the caterpillar is regarded as a friend of the planter, as, by its destruction of the green, succulent growth of the cotton plants, it destroys the food supply of the boll weevil, thus lengthening the period during which the latter must survive without food.

The cowpea pod weevil, *Chalcodermus aeneus* Boh., is frequently and generally reported from all parts of the state, being often mistaken for the boll weevil. Early in the spring, before the cowpeas are up, these weevils assemble upon the young cotton and often do considerable damage by puncturing the leaf and terminal stems, causing their death.

Three other cotton insects which are from time to time locally injurious are the garden web-worm, *Loxostege similalis* Guen., the differential locust, *Melanoplus differentialis* Thos. and a leaf-footed plant-bug, *Leptoglossus phyllopus* Linn.

Sugar Cane Insects

The principal insect enemies of sugar cane are the cane borer, *Diatraea saccharalis* Fab., which also attacks corn, and the mealy bug known in Louisiana as the "poo-a-pouche," lately identified by Mr. J. G. Sanders as *Pseudococcus calceolariae* Mask. This insect is of interest because it seems to be colonized by the Argentine ant, *Iridomyrmex humilis* Mayr. So far as known, it is at present limited to the territory extending from New Orleans to the Gulf of Mexico, the infested area embracing about 1,500 square miles. The ant, however, is well distributed over the southern part of the state, and the appearance of the poo-a-pouche in other localities may be expected at any time.

Insects Injurious to Cereal and Forage Crops

Corn is attacked principally by the bollworm and caneborer, already mentioned, and the southern corn rootworm, *Diabrotica 12-punctata* Oliv., the latter being particularly injurious on alluvial lands.

The principal rice insects are the rice weevil, *Calandra oryzæ* Linn., and the rice maggot, *Lissorhoptrus simplex* Say.

Ontbreaks of the fall armyworm, *Laphygma frugiperda* Sm. & Abb., have been occasionally reported in scattered localities. In July of the present year, Mr. W. C. Harris of Alexandria, La., reported

that they had eaten up 110 acres of alfalfa in three days and were also eating his cotton plants.

The present year has also brought the destructive pea aphis to the attention of the writers for the first time. In April complaints were received from St. Bernard Parish that the cowpea and onion crops were entirely destroyed by insects. The aphis responsible for destruction of the peas was identified by Prof. E. D. Sanderson as *Nectarophora pisi* Kalt., while the onion enemy proved to be the onion thrips, *Thrips tabaci* Lind.

The Colorado potato beetle, *Leptinotarsa decimlineata* Say, is not generally injurious in this state, although it sometimes does damage locally. It is more important in the northern part of the state than in the southern; in fact, is seldom seen in the coast region.

Sweet potato culture in southern Louisiana has been made almost impossible by the sweet potato borer, *Cylas formicarius* Fab., which is rapidly becoming one of our most injurious insects. The habits of this pest make it a very difficult one to control in the field, although fumigation seems fairly effective in protecting the stored tubers.

The cabbage enemies are the usual Harlequin cabbagebug, *Murgantia histrionica* Hahn., and the imported cabbageworm, *Pontia rapae* Sch.

Insects Affecting Deciduous Fruits

Among the Coccids which are more or less injurious to deciduous fruit trees and nursery stock are the San José scale, *Aspidiotus perniciosus* Comst., Putnam's scale, *Aspidiotus ancylus* Putn., cherry scale, *A. forbesi* Johnson, English walnut scale, *A. junglans-regiae* Comst., European fruit scale, *A. ostreaeformis* Curt., and the terrapin scale, *Eulecanium nigrofasciatum* Perg. With the exception of *perniciosus*, the species of *Aspidiotus* are important principally on account of their occurrence on nursery stock, although a few orchard trees have been found very badly infested with *A. forbesi*.

A. perniciosus is widely scattered over the state, being established in practically every section where any large number of peach trees are grown. On account of the long breeding season in Louisiana, this insect multiplies much more rapidly than in the northern states. Young larvæ have been observed in every month of the year.

Another Coccid which has been injurious in a few instances in the southern part of the state is the West Indian peach-scale, *Aulacaspis pentagona* Targ. The state nursery regulations require that this insect be dealt with in the same manner as San José scale, when found in or near a nursery.

The three common peach pests, the peach borer, *Sanninoidea exitiosa* Say, plum curculio, *Conotrachelus nenuphar* Hbst., and shot-hole borer, *Scolytus rugulosus* Ratz. are common. The wooly aphis, *Schizoneura lanigera* Hausm., was very abundant in a few localities in northern Louisiana the past year and the apple-tree tent-caterpillar, *Malacosoma americana* Fab. is lightly distributed over the state.

In August of this year, a serious outbreak of the social grape-caterpillar, *Harrisina americana* Guer., was reported from New Orleans. In one instance this insect had completely defoliated a large number of scuppernong grape vines and was beginning to attack the cultivated grapes on the place.

Citrus Fruit Insects

The principal scale insects attacking citrus plants are the chaff scale, *Parlatoria pergandii* Comst., purple scale, *Lepidosaphes beckii* Newm., long scale, *Lepidosaphes gloveri* Pack., and the circular scale, *Chrysomphalus ficus* Ashm. The latter is also quite abundant on palms. The white fly, *Aleyrodes citri* R. & H., is abundant and injurious. It is common in almost all of the orange-growing parishes with the exception of Plaquemines and Cameron. The orange-dog, *Papilio thoas* Linn., is common but seldom does much damage.

Insects Injurious to Pecans

The common pecan-infesting insects of the state are the walnut caterpillar, *Datana integerrima* G. &. R., the fall webworm, *Hyphantria cunea* Dru., the pecan huskworm, *Enarmonia caryana* Fitch and the hickory twig-girdler *Oncideres cingulata* Say. *Datana integerrima* was especially injurious during 1907, reports of its damage coming in from all over the state.

Two May beetles, *Lachnosterna prunina* Lec. and *L. fusca* Froh., were reported as quite injurious to pecan trees in the northwestern part of the state in 1905. The former species was the more abundant.

Insects Injurious to Shade and Ornamental Trees

Among the Coccids injurious to this class of plants are the rose scale, *Aulacaspis rosae* Sandberg, the camellia scale, *Fiorinia fioriniae* Targ. var. *camelliae*, the two barnacle scales, *Ceroplastes cirripediformis* Comst. and *C. floridensis* Comst., the oleander scale, *Aspidiotus britannicus* Newst., the magnolia Lecanium, *Neolecanium cornuparvum* Thro, the gloomy scale, *Chrysomphalus tenebricosus* Comst. on Camperdown elm, the obscure scale, *C. obscurus* Comst. on oak, the oak-kermes, *Kermes galliformis* Riley, on water oak, K. *pubescens* Bogue,

on swamp post-oak, and *Parlatoria proteus* Curt., on palms, ferns, laurel and sweet olive.

Insects Attacking Man and Live Stock

The yellow fever mosquito, *Stegomyia calopus* Meigen, and the malarial mosquito, *Anopheles maculipennis* Meigen, are man's chief foes in Louisiana. About 40 other mosquitoes are known to occur in the State, but these two, being proven carriers of disease, are of the most importance.

The live stock pests are numerous, chief among them being the hornfly, *Haematobia serrata* R-D., and the screw-worm fly, *Campsomyia macellaria* Fab., the southern buffalo gnat, *Simulium pecuarum* Riley, which annually kills many animals, and the horseflies and earflies, *Tabanus* spp. and *Chrysops* spp. The principal species of *Tabanus* are the green-head horsefly, *T. costalis* Wiedemann, the lined horsefly, *T. lineola* Fab., the American gadfly, *T. americanus* Foster, the black horsefly, *T. atratus* Fab., the autumn horsefly, *T. sulcifrons* Macquart, *T. quinquevittatus* Wiedemann, *T. annulatus* Say, *T. sagax* Osten-Sacken, *T. abdominalis* Fab., *T. coffeatus* Macq., *T. fulvulus* Wiedemann and *T. fuscicostus* Hine. Species of *Chrysops* are numerous, the striped earfly, *C. vittatus* Wiedemann, the brown earfly, *C. flavidus* Wiedemann, the little earfly, *C. pikei* Whitney, *C. obsoletus* Wiedemann, *C. brunneus* Hine and *C. lugens* Wiedemann being the most abundant. The species of *Tabanidæ* assume peculiar importance economically because of their apparent participation in the spread of "charbon," or anthrax.

In opening the discussion on these papers, President Morgan stated that the boll worm is a serious pest in Tennessee. In that state, soy beans are being used to build up the soil. These plants have a habit, like that of cockle burr, of fruiting at almost any time during the season. The worms attack the late pods of the soy bean and the cowpea and prevent the development of seeds. These are the only available food plants for the insect at that time of year and it is a very difficult matter to save the crop.

Mr. Headlee stated that the injury caused by this insect to corn in Kansas has increased in the last few years. In one field he counted one hundred ears and of these ninety-nine were attacked by one or more worms.

Mr. Quaintance called attention to the fact that this insect is a serious pest of cotton in some of the southern states, and referred to the work of the Bureau of Entomology in Texas in 1903 and 1904

and subsequently, the results of which are given in Bulletin No. 50 and several Farmers' Bulletins. He considered it a most difficult pest to control on corn and did not know of any practicable method, other than fall and winter plowing, to destroy the pupæ in the soil. This practice is most effective when followed by all of the farmers in a neighborhood.

Mr. Bruner said that the silo corn crop in Nebraska is often greatly injured by this insect.

Mr. Osborn stated that in Ohio the insect has caused more injury this year than usual, but that it had probably been increasing in abundance during the past few years.

Mr. Sanderson expressed the opinion that in the northern part of the country, the prevalence of this insect is governed by the temperature of the preceding winter.

Mr. Fletcher remarked that soy beans are an excellent trap crop to plant on account of their value as a fertilizer, and Mr. Bruner stated that the red-winged blackbird destroys many of these worms.

Mr. Morgan stated that the elm leaf beetle had been found for the first time in Tennessee, during the summer of 1907, at Ryersville, in the northeastern part of the state.

Mr. Sanderson asked the best remedy for the walnut Datana, as it is very bad in New Hampshire, to which Mr. J. B. Smith replied that it is common in New Jersey and is easily controlled by crushing the larvæ on the trunks of the trees. He had found that only a small per cent of the larvæ pupate and pass the winter. Both arsenate of lead and paris green had been tried as a means of destroying the larvæ.

Mr. Hooker mentioned the fact that in Massachusetts this insect often does considerable injury to the black walnut, though parasitized, at times, by Tachinid flies.

Mr. Morgan stated that in the south this insect is heavily parasitized during some seasons. During the summer of 1907 Datana larvæ caused considerable injury in Tennessee and Louisiana by attacking pecan trees.

Mr. Fletcher spoke of the milky juice of the Norway maple and suggested that this might, in a measure, prevent insect attack. He had found *Lecanium nigrofasciatum* very abundant in two localities, and it had proved very hard to control. In reply to the latter remark, Mr. Symons stated that he had used the lime and sulphur wash against this insect in Maryland and had secured good results.

Mr. J. L. Phillips stated that the maple scale, *Chrysomphalus tenebricosus*, was first observed by him in Virginia in injurious numbers on soft maples at Charlottesville, Va., in 1899. In many cases it had

killed the main part of the tops of the trees, the trunks and larger limbs only showing signs of life. Many of the trees died outright from this attack. It has been doing considerable damage since that date, mainly to trees planted in the parks and streets of the larger cities, such as Richmond, Norfolk, Roanoke, Lynchburg, Staunton, etc.

This winter a fungus growth resembling *Sphaerostilbe coccophila* has been observed quite abundant, attacking this scale insect on some of the trees in Lynchburg. The Park Commission of Lynchburg has been spraying this winter with soluble oil to control this pest. It is his opinion, however, that the infested trees should be gradually removed and replaced by some hardier and more desirable sorts,—some that are not so subject to insect attack.

Mr. J. B. Smith mentioned having found the same fungus in a section of New Jersey, where it had never been introduced artificially, and expressed the opinion that it is of little value in that State.

Mr. R. I. Smith described the manner in which he had introduced this disease into several peach orchards in Georgia. He stated that he first visited a large orchard in Komoko, Florida, in which the San José scale had been largely destroyed, presumably by this disease, which had been introduced the year previous. He found quantities of the fungus on oak trees in and near Atlanta, Georgia, and introduced it into several orchards in the middle and southern parts of the State. This was accomplished by taking pieces of oak bark, which were infested with *Aspidiotus obscurus,* the latter being infected by *Sphaerostilbe coccophila,* and attaching this bark to peach trees infested with the San José scale. From three to six pieces were tied in each tree. This work was done during June and July, 1907, and an examination of one of the orchards in September showed that the fungus had established itself to a slight extent on the San José scale. In some cases fungus was found two or three feet from the specimen which had been tied to the limb, and in one instance it was found on an adjoining tree, upon which no fungus had been artificially introduced. Mr. Smith also mentioned finding *Sphaerostilbe* in the middle of the Hale orchard at Fort Valley, Georgia, while the nearest source of fungus on oak trees was nearly a half mile distant. He recalled finding this fungus very abundant on oak trees infested with the *obscurus* scale in the city of Atlanta, and had found maple trees in the same locality badly infested and dying from the attack of this scale, but none of the fungus was present on these trees. He believed that the work of introducing *Sphaerostilbe* into San José scale infested orchards should be given further attention and careful investigation.

Mr. Forbes gave the results of an attempt to introduce this fungus into Illinois. Artificial cultures were prepared and placed in the orchards during the spring. All of these died out during the summer. A small amount of the fungus was found under cloth bands which had been placed on the trees as tags.

Mr. Worsham gave the results of his observations on this disease in the peach orchards in Georgia, and stated that in some cases a large number of San José scales had been killed by it. He expressed the opinion that before this disease can be of any great economic importance, it will be necessary to secure a liquid substance in which the spores can be mixed, the sticking qualities of which are sufficiently great to enable the spores to adhere to the scales until conditions are favorable for development. He had mixed spores of *Aschersonia* in a gelatine solution of about thirty grams of gelatine to one gallon of water and sprayed orange trees infested with the White Fly with some success, and he thought it probable that some such method might be employed with *Sphaerostilbe*.

Mr. Quaintance called attention to the undesirability of placing too much stress on the importance of fungus diseases in insect control. These diseases are often important natural checks, but in the case of such species, for instance, as the San José scale, the prolificacy and means of spread of the species are such as to render it usually necessary to adopt artificial means of control, such as spraying. So far as he knew, the *Sphaerostilbe* disease of this insect, even in Florida, where moisture conditions are most favorable for its development, could not be relied on in place of spraying, and he thought it probable that lime and sulphur treatment of the trees for scale would greatly check or destroy the fungous disease.

Mr. J. B. Smith pointed out that the season of 1906–1907 was such that experiments with this disease failed to give valuable results. In New Jersey less scale was present in 1907 than had been the case for the past five years, but this was not due to the presence of the fungus.

Mr. Forbes considered that gelatine might be added to the culture material ordinarily used, and that this might assist the fungus in getting established in the orchard.

Mr. Burgess called attention to the effective work which had been done by the fungus disease which attacks the caterpillars of the browntail moth. He thought that if cultures of this disease could be applied under burlaps it might secure a good start. Large numbers of trees in the moth infested district in Massachusetts are banded with strips of burlap, and these strips, particularly in woodlands, retain a considerable amount of moisture, which would furnish good conditions for the development of the disease.

Mr. Sanderson described the recent spread of the gypsy moth in New Hampshire, and stated that small colonies, some of only a single egg cluster each, were being found in the hill towns miles from the nearest known infested point. He believed that the only way of accounting for the presence of these colonies is that there is some means of distribution of this insect which at present is unknown.

This closed the discussion of the papers presented, and the meeting formally adjourned.

We regret that owing to limitation of space it has been impossible to include in this number all of the papers presented by title or otherwise, at the twentieth meeting of the Association of Economic Entomologists. The papers remaining will appear in the next issue.

STATEMENT BY THE STANDING COMMITTEE ON PROPRIETARY INSECTICIDES

At the Chicago meeting it was voted (see page 10, Feb. issue,) that all new proprietary insecticides offered to members of this association be referred to this committee, who will then proceed as suggested in the report of the committee on this matter of last year, Part II.

Your committee has recently received communications from J. W. Lafer, Catawba Island, Ohio, regarding a remedy to be applied to the roots of trees to prevent the attacks of insects and generally stimulate the tree. Mr. Lafer states that some 12 Stations have signified their willingness to test this remedy. Your committee begs to recommend to the entomologists of the association that any tests which may be desired be made after consulting with this committee, so that the number of tests may be reduced in number. It is the judgment of your committee that the testing of this substance is of doubtful expediency until the proportions of its ingredients are known.

Your committee further requests that any new insecticides which are submitted for testing be called to their attention with a statement as to whether the party wishes to make a test of them and any suggestions concerning the matter. We believe that in this way the testing of proprietary insecticides can be much simplified.

As instructed at Chicago, your committee has had prepared, thru the courtesy of the Bureau of Chemistry of the Department of Agriculture, a National Insecticide Law which will probably be introduced during the present session of Congress. Copies will be furnished members of the association as soon as the bill is in print.

E. Dwight Sanderson,
Chairman.

THE PEACH SAWFLY: A CORRECTION.

By B. H. WALDEN, *Agricultural Experiment Station, New Haven, Conn.*

Following the article, *Notes on a New Sawfly Attacking Peach,* in Bulletin 67 of the Bureau of Entomology, page 87, is a note regarding the occurrence of this insect in New Jersey and Pennsylvania. These records do not apply to the peach sawfly, but to the maple stem-borer, *Priophorus acericaulis* MacG., and were given in a discussion following an account of the latter insect by Dr. Britton (see page 94).

The peach sawfly, *Pamphilius persicum* MacG., promises to become quite a serious pest in Connecticut peach orchards. The owners of the orchard in Yalesville where the insect was first found, sprayed over four thousand peach trees during the past season with arsenate of lead and water, using three pounds in fifty gallons. The larvæ were readily killed and the foliage was not injured by the spray. The sawfly has been found in several places in New Haven county and at a distance of about fifteen miles from where it was first discovered. We have received no record of its occuring outside of the State.

An account of the past season's observations regarding the insect has been published in the seventh annual report of the State Entomologist of Connecticut, p. 285.

NOTES ON PSYLLOBORA 20-MACULATA SAY.

By JOHN J. DAVIS, *Urbana, Ill.*

In bulletin vol. 1, no. 1 (technical series) of the Ohio Agricultural Experiment Station, Mr. C. M. Weed writes of having found the larvæ of *Psyllobora 20-maculata* on false or blue lettuce, iron-weed, and various kinds of false sunflower, and as these plants were infested with plant lice, he indicates that they may feed upon them, although no observations to that effect were made.

June 23, 1906, I found the larvæ and one pupa of this Coccinellid on the foliage of the common wild phlox (*Phlox divaricata*) at Homer, Ill. None of these plants were infested with plant-lice and these larvæ were observed feeding upon the epidermal tissues of the leaves.

Mr. Weed gave the length of the pupal life as being about a fortnight, while in my records I found the pupal period to be six days. Mr. Weed's observations were made in the fall and mine were made in the spring. These differences in the lengths of the pupal period may be accounted for by reason of the difference of the effective temperatures in the spring and fall, development being more rapid in the latter than in the former, even though the temperatures may be the same.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN OF THE ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

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The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Reprints of contributions may be obtained at cost. Minor line figures will be reproduced without charge, but the engraving of larger illustrations must be borne by contributors or the electrotypes supplied. The receipt of all papers will be acknowledged.—Eds.

Success is gratifying, and it is a pleasure to announce that our subscription list has already exceeded what most of the editors dared to expect at the outset. Furthermore, the amount of advertising has surpassed our expectations. The financial condition of the Journal is such as to give every reasonable assurance of continued stability. Special thanks for this are due Prof. Wilmon Newell, State Entomologist of Lousiana, who, at the request of the business manager, kindly took upon his shoulders the onerous duties of advertising manager. This and the preceding number bear witness to the value of his services. The advertising privileges of this Journal are open only to responsible parties. The editors cannot undertake to guarantee their reliability, though they have endeavored to exclude all advertisements of apparatus and material of questionable value. It should be remembered that the purpose of advertising is to bring more or less unknown materials to the attention of the public, and the appearance of an advertisement in this Journal must not be construed as an endorsement of the claims made by the advertiser.

This number nearly completes the proceedings of the last meeting of the Association of the Economic Entomologists. We rely upon economic entomologists throughout the country to supply matter for the remaining four numbers, and judging from present indications, there will be no scarcity of first-class material. We trust that all interested in the success of the Journal will bear its needs in mind and use its columns to the best possible advantage. Men contemplating an extended investigation might well announce the same in these columns and thus secure valuable suggestions, and possibly extensive help, from those pursuing similar lines of work in other parts of the country. Coöperation, while it involves some minor sacrifices, offers great advantages to those who avail themselves of its opportunities. The

discussion of methods of work is an exceedingly fruitful line of effort, and it is a pleasure to give in this number a summarized account of the note system which has proved of such great service in the extended investigations upon the boll weevil. No one system is perfect, and undoubtedly there are a number of our readers who have some methods of work which would prove of great service to others if they were only made known.

A rather pessimistic article on the future of Economic Entomology, from the pen of H. T. Fernald, appeared in *Popular Science Monthly* for February, 1908. There is much to be commended in this summary, though we prefer to take a somewhat optimistic view of the situation. While it is true that many farmers in certain sections of the country disregard the recommendations of the economic entomologists, the situation is by no means so discouraging as some would have us believe. This condition is bound to right itself in the near future, since it is only a question of economics. As soon as the agriculturist can see a substantial gain by the adoption of improved methods for controlling insect pests, a sweeping change will result. Such has come about in a number of the more progressive fruit growing sections of New York, and there is a marked tendency toward the adoption of better methods for the control of insects in other portions of the state. The prejudice against the use of insecticides and the disinclination toward the preparation of apparently complex mixtures of insecticides and fungicides is rapidly disappearing, since the less aggressive learn readily from their progressive neighbors. We are far from being discouraged at the outlook. It seems to us distinctly much more promising than ever before. The remarkable progress made in the last decade is an earnest of what may be expected in the near future. It is only necessary to mention such pests as mosquitoes, tsetse flies and cattle ticks to call to mind how the impossible of yesterday has become the thoroughly practical of today. It is true that such destructive leaf feeders as the gypsy moth in Massachusetts and the boll weevil in the South are still serious enemies of the agriculturist. The aim of the economic entomologists is control rather than extermination, and the fund of valuable information respecting both of these species shows beyond question the possibility of controlling them and demonstrates its practicability under most conditions. Furthermore, the outlook is most encouraging in that the fundamentals underlying the control of insect pests are being studied as never before. The work with the parasites of the gypsy and brown-tail moths has been conducted on a hitherto undreamed scale. The investigations of the parasites of the boll weevil not only show the species which prey upon this pest but

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go farther and ascertain their origin and demonstrate the possibility of rearing parasites in native innoxious weevils and practically compelling them to leave the original host and attack this destructive pest.

The present indications are that great advances will be made in the near future. Most of this progress will result from the application or extension of previously recognized truths, rather than from the exploitation of entirely new methods. That there is great need of close investigations of the ecology of injurious species is evidenced by recent advances made possible thereby. We are strongly of the opinion that investigations of entire groups are to occupy a prominent place in the future, because this is one of the best ways of ascertaining every fact which may be of service in controlling an injurious pest. The application of methods found of value in other sciences will doubtless take a prominent place in the economic entomology of the near future. We much prefer to dwell in the New Testament atmosphere with its promises of the disclosure of truth to all, rather than to exist under Old Testament conditions, with its revelations to the few. We are of the opinion that the discoveries of truth are limited only by the opportunity and the visual (mental as well as optical) powers of the observer. We admire Moses, and while leaders are valuable, is it not true that our working entomologists constitute a small army of leaders, all contributing to the attainment of a common goal—the pushing back of the borders of the unknown.

Obituary

WILLIS GRANT JOHNSON

Prof. Willis G. Johnson, associate editor of the *American Agriculturist,* member of the board of control of the New York Agricultural Experiment Station, and until the last few years prominent in entomological investigations, died at his home in New York City, March 11, 1908. He was stricken with slow spinal meningitis and passed away while in the prime of life.

Professor Johnson was born July 4, 1866, at New Albany, Ohio, and received his preparatory education in the Ohio State University from 1884–1887. He was graduated from Cornell University in 1892, with the degree of A. B., receiving A. M. in 1894. He was a post-graduate student in science and instructor at the Leland Stanford, Jr., University from 1892 to 1894. Then he was appointed instructor in the University of Illinois, and was engaged in special agricultural in-

vestigations, preparing at this time his extensive account[1] of the Mediterranean Flour Moth. He was appointed state entomologist of Maryland in 1896, organizing the state horticultural department, of which he became chief. He was also at this time professor of invertebrate zoölogy and entomology in the Maryland Agricultural College, and entomologist to the Agricultural Experiment Station. He organized the State Horticultural Society and at the time he severed his connection with the state was elected a life member, a unique honor. His best work in economic entomology was done in Maryland. He took a leading part in the enactment and enforcement of the law against San José scale, and was the author of several important publications on this pest. Continuing his work upon the Mediterranean flour moth and upon the San José scale, he developed the possibilities of fumigating with hydrocyanic acid gas, particularly in its relation to the control of grain pests in mills. His book entitled "Fumigation Methods," 1902, was the outcome of this work. He continued to write articles on economic entomology for several years after his connection with the *American Agriculturist*, and was also author of several works on other than entomological subjects. He resigned his position as state entomologist of Maryland in 1900 and became associate editor of the *American Agriculturist*, a position which he held to the time of his death. Professor Johnson was an exceedingly active man, being a member of a number of scientific associations, such as the American Association of Agricultural Colleges and Experiment Stations, Society for the Promotion of Agricultural Science, American Pomological Society and the Association of Economic Entomologists. He was appointed in July, 1907, a member of the board of control of the New York State Experiment Station, and had been for several years a director of the American Institute of New York City. He is survived by his wife, a son and a daughter. His mother and several brothers reside at Columbus, Ohio. Interment was at Lake View, Ithaca, N. Y.

The multifarious duties of an editorship prevented his giving much attention to entomology in recent years, though he maintained to the last a keen interest in this branch of work. In the death of Professor Johnson, economic entomology has lost an enthusiastic, aggressive champion, and the sad news has caused profound sorrow among entomologists throughout the country.

E. P. F.
A. F. B.

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[1]1896, 19th report of the State Entomologist of Illinois, Appendix, p. 1–66.

CHARLES ABBOTT DAVIS

Mr. Charles Abbott Davis, curator of the Roger Williams Park museum at Providence, R. I., died at the Rhode Island hospital January 28, 1908, from cerebro spinal meningitis.

He was a devoted student of natural history and was particularly interested in entomology and shells. He was a member of many societies, among which were the Entomological Society of America, Aggassiz Association and the Rhode Island Field Naturalists' Society, having organized the latter.

A. F. B.

Reviews

Studies of Parasites of the Cotton Boll Weevil, by W. Dwight Pierce, U. S. Department of Agriculture, Bureau of Entomology, Bulletin 73.

Theoretically at least, the best method of controlling an injurious insect is by encouraging its natural enemies. All economic entomologists recognize the value of parasites and predaceous forms as checks upon the multiplication of insect pests, and many have made more or less general recommendations with a view of obtaining the greatest possible assistance from these agencies. Careful studies have been made of the parasites of several of our more important insect enemies such, for example, as the exhaustive study by Dr. Howard, of the parasites of the white marked tussock moth, and a careful investigation by Fiske, of the parasites of the common tent caterpillar. The parasites of the Coccidae, thanks again to the work of Dr. Howard, are relatively well known, and enemies of this group have been successfully introduced into localities and very satisfactorily controlled dangerous outbreaks of their hosts. The bulletin under consideration is specially noteworthy, in that it gives a large amount of accurate data relating to the parasites of an entire group in a faunal area. The investigator has ascertained the sources from whence come the parasites attacking the boll weevil. A study of the biology of the native host forms has shown the possibility of taking advantage of natural conditions within certain limitations so as to force insects, normally subsisting on species of small or no economic importance, to attack one of our most dangerous pests. Such methods can be employed to advantage only after the factors controlling the existence of these forms are thoroughly understood. These studies are a striking illustration of the importance of thorough investigations of an entire group. The author is to be congratulated upon having produced a very valuable and suggestive contribution to economic entomology.

E. P. F.

Report of the Entomological Department of the New Jersey Agricultural College Experiment Station for 1907, by John B. Smith, pages 389–560.

This publication appears in its usual form, and like its predecessors contains numerous valuable observations upon the more injurious species of the

year, special studies being made upon root maggots. In reporting upon field tests of insecticides for controlling San José scale, Dr. Smith states that lime-sulphur washes have not gained in favor in New Jersey, though they have fully held their own. He reports good results as being almost invariably obtained when a miscible oil, such as scalecide, is used, and devotes considerable space to the discussion of home made miscible oils. The somewhat extended evidence respecting the application of bands of carbolic acid to trunks of trees is by no means favorable to this method of treatment. Brief notes are given on some new materials which may possibly be used as insecticides; namely, arsenate of iron, arsenate of lime and arsenate of barium.

About half of the report is deservedly occupied by an account of the exceedingly important work against mosquitoes done in 1907. Details are given respecting methods and the amount of work accomplished in different localities. We regret that the author has not seen fit to incorporate in this portion of the report a summarized statement as to what has already been accomplished along this most practical line of effort, so that one can, in a short time, gain an adequate idea of the progress made in freeing New Jersey from the blood-thirsty swarms of mosquitoes. One of the most interesting occurrences of the year was the discovery of the larva and breeding habits of *Culex perturbans*, a species which up to last year had eluded the vigilance of all Americans working upon the biology of this group.

E. P. F.

Report on the Injurious Insects and Other Animals Observed in the Midland Counties during 1907, by WALTER E. COLLINGE, 58 pages.

This report gives summarized accounts of a large number of the more important injurious insects, together with reports on insecticides and fungicides. Experiments in controlling the gall mite on black currant, *Eriophyes ribis*, show that spraying with the lime-sulphur wash is most effective. Reporting upon a series of experiments for destroying all insects and other injurious organisms inhabiting the soil, Prof. Collinge states that he has obtained a fumigant designated as "Apterite" which will effectually rid the soil of these enemies. This is presumably a proprietary material, as no clue is given respecting its composition. The general appearance of this report is exceedingly good, the letter press and paper being much above the average.

E. P. F.

Current Notes

Conducted by the Associate Editor

The ASSOCIATE EDITOR will be engaged during the summer in work on predaceous beetles which are being imported to assist in controlling the gypsy moth. After May 1st all communications should be directed to *Melrose Highlands, Mass., Care Gypsy Moth Parasite Laboratory*, instead of to Washington, D. C.

Graduate School of Agriculture. The preliminary announcement of the

third session to be held July 6th to the 31st, 1908, at Cornell University, Ithaca, N. Y., and at the New York Agricultural Experiment Station, Geneva, N. Y., gives the following list of entomologists on its faculty:

Dr. L. O. Howard, chief, U. S. Bureau of Entomology; Prof. S. A. Forbes, professor of zoölogy, University of Illinois; Prof. M. V. Slingerland, assistant professor of economic entomology, Cornell University; P. J. Parrott, entomologist, New York Agricultural Experiment Station; Dr. James G. Needham, assistant professor of limnology, Cornell University; Dr. A. D. MacGillivray, assistant professor of entomology, Cornell University; Dr. W. A. Riley, assistant professor of entomology, Cornell University; Prof. E. Dwight Sanderson, director and entomologist, New Hampshire Agricultural Experiment Station; Dr. E. P. Felt, state entomologist of New York.

A provisional program will appear shortly. The JOURNAL hopes to publish all the best papers given in the course on entomology.

The Louisiana Naturalists Society held its first meeting of the year Saturday, Feb. 1st, at the State Museum at New Orleans. There was a very large attendance and several important papers were read and discussed. Mr. J. B. Garrett of the Louisiana State Experiment Station read a carefully prepared paper on the "pou-a-pouche" (*Pseudococcus calceolariae*) which is a source of injury to the sugar cane. Mr. Blouin outlined the experience of the Audubon Park Experiment Station with the same insect. Mr. E. Foster read a short paper on some forms of Entomostraca occurring in New Orleans. Mr. Foster has for years been making a special study of these organisms in which the waters in the vicinity of New Orleans are particularly rich. Mr. J. C. Smith, who is well known as an authority on Protozoa, gave a short talk on a species of algae which had been most disagreeably abundant in Lake Pontchartrain a few months back. Mr. R. S. Cocks exhibited photographs of what may prove to be a new species of honey locust, *Gleditschia*, discovered near Shreveport. The society then adjourned. This society has met continually since 1897, it consists of about 60 members residing in different parts of the state and has for its object the study of all departments of natural history. The present officers are: President, Prof. B. H. Guilbeau, Secretary, R. S. Cocks, Treasurer, Mr. G. R. Westfeldt.

We have been recently advised that Prof. J. L. Phillips, State Entomologist of Virginia, is in need of an assistant in the orchard and nursery inspection work of his office.

Mr. H. E. Hodgkiss has resigned his position as Assistant to the State Entomologist of Illinois and returned to his former position at the New York Agricultural Experiment Station. Address, Geneva, N. Y.

Prof. Walter E. Collinge, head of the Department of Economic Zoölogy in the University of Birmingham, and Editor of the "Journal of Economic Biology," has accepted the responsible position of Director of the Cooper Research Laboratory at Berkhamsted, England.

Appointments in the Bureau of Entomology, Washington, D. C.:

Mr. G. E. Merrill of New Hampshire has been appointed as a special field agent and will take charge of demonstration work in orchard spraying in Nebraska.

Mr. C. B. Hardensberg, a graduate of the University of Wisconsin, and a graduate student at the University of Pennsylvania, has been appointed special field agent and will be engaged in the investigation of insects affecting cranberries in Wisconsin during the season.

Mr. Victor S. Barber of California has been appointed special field agent and will be engaged in investigation and demonstration work for controlling forest insects.

Prof. Trevor Kincaid, Professor of Zoölogy at the University of Washington, Seattle, Wash., has been selected by Dr. Howard to collect parasites of the gypsy moth in Japan. He sailed for that country March third. The work is being undertaken by the Bureau of Entomology in coöperation with the State of Massachusetts. Shipments of parasites from Japan that have been received in the past have arrived in unsatisfactory condition and it is desired to employ every means possible to secure and utilize any of their beneficial insects. Prof. Kincaid was selected on account of his experience as a collector, having been a member of the Harriman Expedition which made extensive collections in Alaska several years ago. His location on the Pacific coast also made him particularly available for the work. Previous to his sailing, the Japanese entomologists were notified by Dr. Howard and much assistance will be secured from them in obtaining parasitized material.

Mr. C. H. T. Townsend of the Bureau of Entomology has been transferred from Washington to the gypsy moth laboratory at Melrose Highlands, Mass., where he will have charge of breeding and rearing the imported Dipterous parasites of the gypsy and brown-tail moths.

The Committee on Agriculture of the house of representatives of the 60th Congress has reported the following appropriations for the Bureau of Entomology:

For the Bureau of Entomology	$184,960
For prevention of the spread of gypsy and brown-tail moths	250,000

The committee also recommends an appropriation for the Bureau of Animal Industry of $250,000 for eradicating the cattle tick.

Mr. C. H. Popenoe of the Bureau of Entomology is investigating truck crop insects at Norfolk, Virginia. Particular attention is being given to a study of the pests affecting spinach and strawberries.

Volume 9 of the Proceedings of the Entomological Society of Washington for the year 1907 will be issued during the present month. The numbers will be published quarterly hereafter.

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(Continued from April number)

The following papers were read by title, on account of the authors being absent, and as the manuscript has been forwarded to the secretary they are included as a part of this report:

THE ORANGE WORM

(Trypeta ludens)

By PROF. A. L. HERRERA, *Chief of the Commission of Agricultural Parasitology, Mexico.*

This worm has been the object of long work tending to its destruction, said work being begun during the year 1900, when was established the Commission of Agricultural Parasitology, in the City of Mexico, which was especially intrusted with the work of combating the pest. The alarm among the Mexican orange growers was the result of the promulgation in California of a law whereby was forbidden the importation of the Mexican orange, without any distinction as to the place of origin, and under the supposition that every orange grown in Sonora, Nuevo Leon, Tamaulipas, and other states of the Mexican Republic, also contained the germ of a dangerous plague. Through the investigations and studies of the Commission of Agricultural Parasitology, it has been demonstrated that this pest exists only in the tropical parts of Mexico, particularly in the states of Guerrero and Morelos, and above all in Yautepec, where over 500 orange orchards are in full production.

As it was considered or thought that the pest was easy to be fought

and controlled, and that really it would present no danger in a cold or temperate country, the Mexican government invited Mr. J. Isaac, secretary of the Board of Horticulture of California, to come to Mexico during the month of March, 1905, and we accompanied him on several of his excursions. Afterwards, Mr. Isaac published a very important report (California State Horticultural Commission: Report of the Commissioner Appointed to Investigate the Prevalence of Trypeta ludens in Mexico. Districts Affected by the Orange Worm. Nature, Habits and Extension of the Pest. Methods Adopted for Its Control. Danger to be Apprehended from its Introduction, Etc. Sacramento, 1905, p. 1–48; Plates and Maps.)

The methods adopted to control this pest have been, lately, the subject of a report presented to this commission by Mr. W. W. Froggatt, commissioned by the British government to study the pests of the fruits, and who was in Mexico, coming from Australia, during the month of November of the present year. He visited Yautepec, the center of the pest and also of the work of the Commission of Agricultural Parasitology. According to Mr. Froggatt, the control work, conducted by this Commission, has been efficacious and within one or two years the pest will practically be of no moment.

It must be observed that every orange leaving Yautepec for Mexico or other parts, is carefully examined by skillful persons, well acquainted with the matter, and they confiscate every fruit having spots due to the sting of the ovipositor of the fly, or bearing any other sign of being attacked by worms. The examination is conducted at the railroad station or in the orchards. Thus is greatly lessened the danger of the worms infesting the orchards of other countries, provided the shipments come from Yautepec and not from other warm parts of Mexico.

In any case, however, the danger of infestation by this pest is rather problematical, since, according to my own observations, the fly remains completely inactive during the cold days; it is an insect of the tropics, and to be able to live and multiply it requires a medium temperature of at least 21 degrees. Once, it made a sporadic appearance in the temperate climate of Guanajuato in but one orchard. It lasted one year and was controlled. The following year a few flies appeared, but were not given time to multiply, being attacked by the same means. Since then, Mr. Dugès thinks the pest has never been seen any more. The same occurred in Zacatlan, in the State of Puebla. The flies were seen one year on pears but have not made any further appearance.

Lately the pest was thought to infest also the Mamey (*Mammea*

americana), but it has been found that it is another species (*Anastrepha serpentina*).

Means of control.—For the last seven years the pest has been combated, in Yautepec, by burning or burying the fallen fruit from the trees and cleaning of the orchards; the old wooden and thorny fences are replaced by wire fences; the orchards are carefully cultivated and the intercalar crops of sugar cane, "jicama," (*Dolichos*), etc., have been suppressed. One of the means that have been tried during these last months consists in injecting in the fallen fruits some gasoline or benzine, thus avoiding the transportation of heavy loads of oranges to the incinerating furnaces or burying ditches. These injections are performed by a workman who perforates the fallen oranges not yet rotten with a nail or any pointed tool, in but one place, so that the hole thus formed be of about the same diameter as a large pencil: then he squeezes the fruit in order to extract a large amount of its juice, and another man gives him an ear-syringe filled with gasoline or benzine, which is injected in a sufficient quantity, that is, all that may be contained inside of each orange.

The cost of this treatment is, approximately, from 15 to 20 dollars, Mexican money, for every 10,000 fruits. I think that this amount could easily be reduced if an automatic injector were used, which is not necessary for the present. According to practical informations from the agents of the commission, a workman may inject 250 oranges an hour, and therefore six workmen at work for eight hours a day will inject 12,000 oranges. The larvæ do not perish immediately, but they fall into lethargy under the effects of the vapors from the benzine, which slowly spread through the pulp of the orange and thus impede the exit of the larvæ already fully developed and ready to bury themselves.[1]

Parasites.—Since 1907 I have tried, very earnestly, to find the parasites which might help in the destruction of the fly. At first was discovered the *Cratospila rudibunda*, a species of wasp (*Braconidae*), which lays its eggs on the larvæ, through the skin of the guavas and mangos, but unfortunately its ovipositor is very short and could not penetrate to the interior of the oranges. This parasite could not be bred and besides is very scarce in Yautepec.

At Cuernavaca, a horticultural center of great importance, the guavas and mangos are infested by the *Trypeta ludens* and *acidusa*, but there are no orange groves in that place. With great care did I

[1]Mr. Froggatt says that in Australia they have been using petroleum with water to attract the flies, but the experiments made at Yautepec so far have given very little results.

look for the parasites on the fruit fallen under the trees; I found many articulates, which were classified by specialists of the Washington Bureau and they are the following ones:

A larva of *Elateridae*, belonging to *Melanotus* or some allied genus. As far as known, the larvæ of this genus live underground on the roots of various plants.

Stelidota geminata, Epuraea labilis. Both belong to the family *Nitidulidae*, or sap beetles, and are known to feed on decaying fruit and similar substances.

A Staphylinid beetle of the genus *Osorius*, the species being in all probability undescribed. This is certainly not injurious to fruit, the species of this genus living in the ground.

Larva of *Anastrepha (Trypeta) ludens* Loew.

A Curculionid larva, probably belonging to the genus *Conotrachelus*.

Species of this genus attack and injure healthy fruit, and an effort should be made, therefore, to breed the perfect beetle. This insect, however, was never found any more as injuring the fruit.

A Carabid larva belonging to the subfamily *Lebiinae*. The larvæ of this subfamily of *Carabidae* are predaceous.

Proctotrypes n. sp. Parasitic in larva of some insect.

A Staphylinid of the genus *Homalota*. The species of this and allied genera are certainly not injurious to the fruit.

A Coleopterous larva. (*Dermestidae*?)

Apharacta n. sp. Probably parasitic on *Anastrepha* or else on some Dipterous scavenger.

I have not tried to cultivate in vitro, the *Proctotrypes* or the *Apharacta*, because they seem to me of very little efficacy, even when they have the best climatic conditions, and moreover they are very scarce, and therefore the plague is causing great damages in the Cuernavaca fruit, where the orchardists are still more indifferent than at Yautepec, and do not pay any attention to the destruction of the fallen fruit.

I have made up my mind to keep up during the year the study of the parasites of *Trypeta ludens*, at the various stations. Neither did Mr. Froggatt find, at Yautepec, any important parasite of the orange worm, and as to the parasites recommended by Compère, and which he claims to have discovered in Brazil, they have been useless, according to the information of Mr. Froggatt and Mr. Lounsbury.

As to the *Hexamerocera brasiliensis*, advocated by Von Ihering, thus far it is not known whether it is efficacious.

To conclude, I will say that the danger of infection of the United States orchards does not appear to me as formidable as it has been claimed to be, owing to the difference in the climate, since it is a question of a tropical insect, and besides, though for the last 24 years worm infested oranges have been introduced into the United States, yet it is not known that the pest has appeared in any Florida or California orchard. Since 1884, the orange worm has been imported with the fruits proceeding from Mexico, and sold at New Orleans (Riley. "Insect Life," t. I, p. 45), a seaport which is not far away from the Florida orange groves.

Places in Mexico where oranges are produced abundantly, and are not infested by the Trypeta ludens.—Sonora, Aguascalientes, Chihuahua, Colima, Jalisco, Nuevo Leon, San Luis Potosi, Zacatecas. Most particularly, the orange from Autlan, Guarachita, Rio Verde, is never affected by the worm. It is but just, therefore, that not all of the oranges from Mexico be prohibited, rejected or subjected to examination. The Sonora and Jalisco fruit is extensively exported to the United States and this fruit is never wormy.

Mexico, December 7, 1907.

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[1] The above paper was accompanied by a large, admirably executed colored chart showing the pest in its various stages and also by many illustrations from John Isaac's special report, cited above, to which specially interested parties are referred.

A NEW ROOT PEST OF THE VINE IN CALIFORNIA

By H. J. Quayle, *Berkeley, Cal.*

In 1883 Matthew Cooke in his book, "Injurious Insects of the Orchard and Vineyard," gave an account of an insect attacking the grape vine in California which he called the Imported Grape Flea-beetle (*Adoxus vitis*). He confused this insect with the true flea beetle, and this mistake has continued in the accounts of the insect that have appeared in the literature of the state ever since.

It is now known that this insect is closely related to the grape root worm (*Fidia viticida* Walsh) of the eastern states and is improperly called a flea beetle. The life history, as it has been worked out during the past season, is briefly as follows: The beetles appear in May and June, when they feed on the growing parts of the vine above ground, including the leaves, tender shoots, petioles, pedicels, and even the berry itself.

The eggs are laid in clusters of four or five to fifteen or twenty on the stump of the vine beneath two or three layers of the old bark. From eight to twelve days are required for hatching and the young larvæ make their way to the roots, where they feed until the vine becomes dormant. By September some are about full grown, while others are but half grown. These latter resume feeding in the following spring. Pupation occurs within from four to eight inches of the surface of the ground during the latter half of April. The pupal stage lasts two weeks and the beetles begin emerging about May first.

Two forms of the beetle occur in about equal numbers in the state, one being wholly black, while the other has the elytra, tibiæ and basal half of the antennæ brown. These are known as *Adoxus vitis* and *Adoxus obscurus*, but they are undoubtedly simply two forms of the same species, since they are always found together and breed indiscriminately.

Adoxus vitis is a well-known pest of the grape in France and specimens received from there are identical with the brown form occurring here. Numerous specimens were sent me by Professor Valery Mayet of Montpelier, France, but only two specimens of *Adoxus obscurus*, which he states is very rare, and found only on a plant of the marshy prairies, and never upon the grape vine. The *obscurus*, as it is known in France, is apparently a distinct species, while what has been called *obscurus* in this state appears to be simply a form of *vitis*. Specimens from France and California have been submitted to Mr. A. E.

Schwarz of the Bureau of Entomology for determination, but his report has not been received at the present writing.

This insect has been known to occur in California for a good many years and its economic status has been based entirely on its leaf-feeding habits. This above ground injury to the vine, while it has been very great in some cases, is really unimportant as compared with the more serious and permanent injury to the roots. In some vineyards the crop has been reduced a third or a half and in one instance that came under our observation this year, two or three acres of vines were dug up on account of the injury to the roots by the larvæ of this insect.

APHIS GOSSYPII GLOV., AND ITS ALLIES—MEDICAGINIS KOCH, RUMICIS LINN., FORBESI WEED, OENOTHERIAE OEST., AND CARBOCOLOR GILL.

By C. P. Gillette,[1] *Fort Collins, Col.*

In my study of the *Aphididæ* of Colorado I have become convinced that there is still considerable confusion in the literature treating of the species having a close resemblance to *Aphis gossypii* Glover. I do not pretend to be able to straighten out all the crooked places, but hope to be able to offer observations and conclusions that will help to that end.

For several years past *Aphis gossypii* has done more harm than all other insect pests together to the canteloupe and melon vines grown in the Arkansas Valley in this state. In accord with the observations made by several other writers, the first appearance of the lice upon the vines takes place when the latter are just nicely beginning to run, but they seldom attract much attention until the vines are two feet or more in length. Once upon the vines, the lice increase with great rapidity. In our breeding cages Mr. Bragg has repeatedly reared new-born lice to the reproductive stage in eight days, and a common number of births per day has been from six to twelve. As a result the enemies,—parasites, ladybeetles and syrphus flies, finding an unstinted supply of food, also multiply rapidly and by about the second week of July often cause the lice to rapidly decrease in numbers and so save a large proportion of the melon crop. The lice continue upon the vines however to the time when killing frosts render the plants

[1] I wish especially to acknowledge the assistance of Mr. L. C. Bragg in accumulating the data for this paper.

no longer of service as food. During July winged individuals become very scarce, but the winged lice soon appear in considerable numbers and continue throughout the year.

Identification of Species

Aphis gossypii Glover.

Our observations upon this species continued for nearly a year before we were able confidently to separate it and *medicaginis* Koch. from each other and from closely related forms. Some of the distinguishing characteristics which later enabled us to do this are the following:

In *gossypii* the black appearing apterous females are really a very dark green; they nearly always have some light mottling upon the dorsum of the abdomen, due to the light colored embryos showing through, and these dark females are *never* highly polished.

Fully mature apterous females have antennæ and cornicles distinctly longer than in *medicaginis*.[2]

The larvæ of the first, second and third instars, especially of the winged form, nearly always show a distinct yellowish brown or pale salmon colored area upon the dorsal portion of the abdomen anterior to the cornicles and a conspicuous dark transverse band at the cornicles.

There is nearly always much variety of color in both the young and the adult apterous individuals, some being very dark, to the naked eye appearing black, and others with intergrading shades passing to very light yellow or tan colored viviparous females. The offspring of these light individuals may be as dark as the darkest through their entire life.

The pupæ are beautifully tessellated over the dorsum of the abdomen with silvery white.

So far as our observations have gone, *gossypii* has not been found colonized upon so large a range of food plants as *medicaginis*, which seems to be able to thrive upon almost any green thing.

Sexual forms and eggs we have been unable to find.

Aphis medicaginis Koch.

The fully adult apterous viviparous females of this species we have found, without exception, deep black and highly polished. They shine like glass beads among the other lice of the colonies and may be very few in number or entirely absent.

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[2] Care must be taken not to mistake immature individuals, just before the last molt, for the fully mature form; they may be fully as large but they have very much shorter cornicles and antennæ.

The pupæ, while much resembling those of *gossypii*, do not have the tessellated dorsal spots so silvery white.

The young larval forms do not have the characteristic yellowish brown color of *gossypii* upon the dorsum of the abdomen nor the green transverse band, and there is not the range of light and dark forms among the apterous lice found in the colonies.

The tibiæ and basal half of the antennæ are more conspicuously whitish than in allied species.

This species has been specially partial to white sweet clover and *Glycerrhiza lepidota* here, two plants upon which we have never taken any of the allied species.

Sexual forms and eggs we have not been able to find.

Aphis rumicis Koch.

It seems almost certain that several writers, including Oestlund in his description,[3] have reported *medicaginis* as *rumicis*. I do not think that the *rumicis* of Linnæus has come under our observation, unless, possibly, it proves to be the same as *carbocolor* Gill.

Aphis carbocolor Gill.

This louse is somewhat larger and more robust than *medicaginis*, the adult apterous individuals are all deep dull sooty black, never polished, and it passes into the sexual forms in the fall, the females of which deposit eggs in great numbers about the crowns and bases of the leaves and stems of species of *Rumex*, especially the yellow dock. The cornicles are decidedly shorter and weaker than in *gossypii* or *medicaginis*. Winged viviparous females are shining black upon both thorax and abdomen. The seventh antennal joint and the antenna as a whole are longer than in *medicaginis*.

Aphis oenotheriæ Oest.

This louse has been considered a synonym of *gossypii* by Sanborn, which is probably a mistake as this is a green louse, occurring upon the primrose only, so far as we have observed, and never having the black apterous females of *medicaginis* nor the variety of colors exhibited by *gossypii*. It is possible that Prof. Sanborn had true *gossypii* from *Oenothera* and that he had not seen true *oenotheriæ*, which is a very common species in Colorado and quite distinct from *gossypii*.

Aphis forbesi Weed.

I would not include this species as belonging to the *gossypii* group were it not for the fact that it has been confused with *Aphis gossypii*

[3] Bull. 4, Synopsis of the Aphididæ of Minn. p. 61.

in a few instances. Prof. Sanderson[4] has already recognized it as a good species. We have not taken this louse in Colorado, but specimens that were sent me by Mr. J. J. Davis, State University, Urbana, Illinois, have been examined and prove to be easily distinguishable from any of the other species mentioned in this paper. In about three fourths of the examples examined, all of which were apterous females, the third and fourth joints of the antenna were united in one with no signs of a dividing suture. Dr. Weed in his description of this species describes it as having six-jointed antennæ. In the specimens having joints 3 and 4 separate, joint 3 but slightly exceeded joint 4, and the two joints together made one sub-equal in length with joint 7. In *gossypii* joint 3 alone is always longer than joint 7. *A. forbesi* is also smaller and is a root feeder.

Influence of Host Plant upon Aphid Characteristics

An impression seems to be more or less prevalent that a species of plant louse may vary much in structure and general appearance, depending upon the plant upon which it lives and draws its nourishment.

In all our experience transferring lice from one food plant to another and observing them upon widely varying plants in a state of nature or in hot-houses, we have never had any reason to think that a species is perceptibly changed in appearance because of a change of food plant. I am aware that there are migrating forms that are different in appearance from their immediate ancestors and that they may go to a different food plant, but in such cases the change came before migration or was "predestined" to appear in the first generation after migration. For example, the stem mother of *Phorodon humuli* upon the plum is quite different from the migrant that goes back to the hop[5], but the change came before deserting the plum. The oviparous female in the fall, which is the product of the return migrant from the hop, is very different from the migrant, but not at all because of its change in diet. It is the sexual female form of the species and what it develops into was determined in every case before the parent left the hop. Such changes as these, coincident with a change of food plant in the life histories of plant lice, can be duplicated many times over by instances where there is not a change of host plant. As familiar illustrations recall the remarkable variations

[4]Bull. 49, Del. Agr. Sta.

[5]I do not mean by this that the viviparous females upon the plum can be distinguished from the viviparous females upon the hop.

in the forms of *Phylloxera vastatrix*, which remains throughout life upon the grape, and of *Schizoneura lanigera*, remaining upon the apple, or of *Schizoneura americana*, without leaving the elm.

Do Aphis gossypii and medicaginis Lay Eggs?

Mr. Pergande mentions two instances where he thinks he may have discovered eggs of *gossypii*, but from his written statements it seems that he has not seen the sexual forms, and the probability of the eggs found being the eggs of *gossypii* does not appear to be very strong. For two years we have followed these lice closely without ever finding sexual forms or eggs at any time of the year. During 1906–'07 both these lice were followed all winter upon out-of-door plants by Mr. Bragg, and the present winter they have been followed into December, past several zero nights, and they are still in fine condition, but no males or oviparous females or eggs have been discovered. I would not dare express the opinion that sexual forms never appear in these species, but so far as our observations go, it seems very doubtful about their occurring in Colorado. We shall continue to search carefully for them.

Food Plants

As mentioned above, we have seen *Aphis oenotheriæ* upon the primroses only, and *A. carbocolor* has been taken by us upon no plants outside of the genus *Rumex*.

Aphis gossypii we have taken colonized from the cotton plant, canteloupe, muskmelon, watermelon, cucumber, winter squash, pumpkin, the native wild gourd (*Cucurbita foetidissima*), Shepherd's purse (*Bursa B-pastoris*) (which is its favorite plant upon which to spend the winter in Colorado), iron weed (**Ambrosia trifida*), mare's tail (**Erigeron canadensis*), *Rumex* sp. *Convolvulus* sp., *Lepidium virginicum*, **Taraxicum dens-leonis*, **Asclepias* sp., and in the summer upon the leaves of buckthorn (*Rhamnus cathartica*) and *Catalpa speciosa*. We have never found it upon strawberry or purslane, though looked for much upon these plants. Many of the other plants that have been named as the hosts for this species, and which have come under our observation in Colorado, we have found infested by colonies of *Aphis medicaginis*. I do not mean to say that I think the records that have been given for *gossypii* on these plants are incorrect, but simply state the results of our observations in Colorado.

The plants upon which we have observed *Aphis medicaginis* established and colonized are: White sweet clover, yellow sweet clover,

*Found on one plant only.

red clover, white clover, alfalfa, several species of native locos and lupines, wax beans, black locust, licorice (*Glycerrhiza lepidota*), apple, pear, plum, soft maple, boxelder, shepherd's purse (apparently its favorite over winter plant here), *Lepidium virginicum*, *Chenopodium* sp., *Rumex* sp., *Malvastrum coccineum*, primrose (*Anogra albicaulis*), Tansy mustard (*Sophia* sp.), dandelion and lawn grass (*Poa* sp.).

THE CATALPA BUD MAGGOT

By H. A. Gossard, *Wooster, Ohio*

For several years the tender growing twigs of catalpa have been attacked by insect larvæ, causing the twigs to become slightly swollen and to blacken and wilt at the terminal end. This trouble was so pronounced and excited so much complaint among the catalpa growers in various sections of Ohio, that the questions relating to it were referred to Mr. J. S. Houser for special investigation.

From an investigation made in the spring of 1907 of all the twigs on 15 three-year-old trees growing at Wooster, 49 per cent of them were found to have been damaged by this pest. Mr. Houser's description of the injury is as follows:

"The tender growing twigs of catalpa are attacked by maggots, causing the twig to become slightly swollen and to blacken at the point of injury. This occurs usually about three or four inches below the tip during the early part of the season, and at a lesser distance down later on when the twig is growing less rapidly. The twig above the injury dies. Following the death of the tip in early summer, the next node below develops one or more tips and frequently a cluster of leaves, giving the twig a bushy growth (Plate 1); following the later attacks the stem appears as in Plate 2, figure 1. The ultimate result after continued topping is a stunted, crooked, forked growth. (Plate 2, figure 2.)"

A large series of infested twigs were enclosed in breeding jars, the cuttings being sunk into moist earth. The specimens were collected at various periods of the growing season and through two summers. Though it seemed quite certain from some larvæ found in the affected terminals that a Cecidomyid would be obtained, it was not until the second summer that a midge was reared that seemed to agree with the description of *Cecidomyia catalpæ*, hitherto recorded as infesting the pods and destroying the seeds of catalpa. The few specimens obtained have been examined by Mr. Coquillett and Dr. Felt, and while both are agreed that the specimens are near *C. catalpæ*, they reserve

final decision until the specimens can be compared with Comstock's types.

Quite often, instead of midges, chalcids would appear in the cages. Mr. Crawford of the Bureau of Entomology pronounces these insects to be of a new species, belonging in a new genus, and he proposes to describe the species as *Zatropis catalpæ*. Whether the chalcids were present in the catalpæ shoots as parasites on the midge larvæ, or whether, like the wheat-joint worm and a few other members of the family, they are primarily injurious to vegetation, I cannot at present state. It is not impossible that the midges work on the tender leaves at the terminal end of the twigs, and that the chalcids insert their eggs in the soft wood lower down. Several specimens of the chalcid were obtained this season, all issuing between the middle of July and the middle of August. The three midges obtained emerged August 7, August 8 and September 3, respectively.

THE CALIFORNIA LIFE HISTORY OF THE GRAPE LEAF-HOPPER

Typhlocyba comes Say

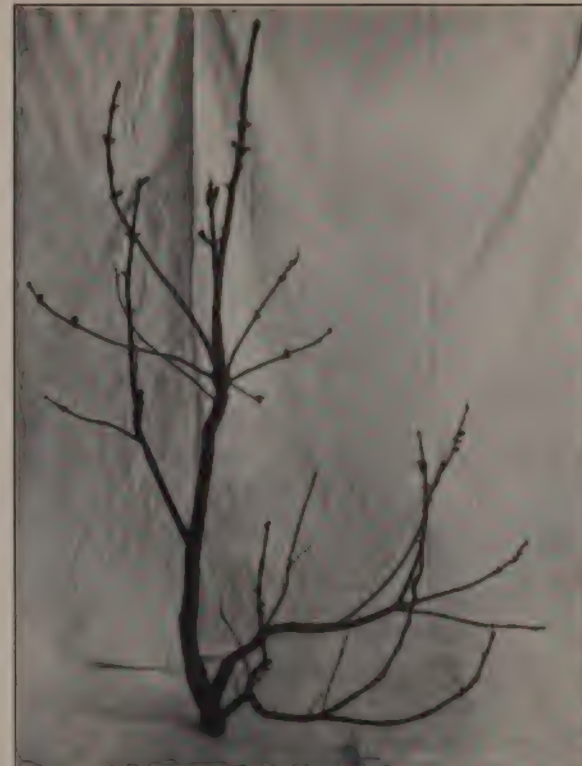
By H. J. Quayle, *Berkeley, Cal.*

Climate is a well-known factor in influencing the life history of insects, and so in California most, if not all, of our insects of economic importance have some points in their life-history that differ from those of the same species in the eastern states. Usually this difference is in the number of broods or length of the period of development, and less often a distinct variance in habits.

The grape leaf-hopper in California over-winters as an adult insect, feeding on a wide range of food plants during the warmer days; or remaining more or less dormant in bunches of leaves in the vineyard or low down in the dense vegetation of the bordering roadsides and fences during the cold or wet weather. As soon as the foliage appears on the vine in the spring they leave their varied winter food-plants and attack the grape exclusively. After feeding for about three weeks on the vine, pairing begins and eggs will be deposited one week later. This will be about May 1st in the lower Sacramento and San Joaquin valleys. Records were kept on twenty eggs from different hoppers and they required from seventeen to twenty days for incubation. Nymphs hatching from these eggs require on an average eighteen days to go through their five nymphal stages. The duration of each of the stages, summarized from observations on about fifty hoppers, is as

WORK OF CATALPA BUD MAGGOT
(After Houser, courtesy O. Agr. Expt. Sta.)

1.



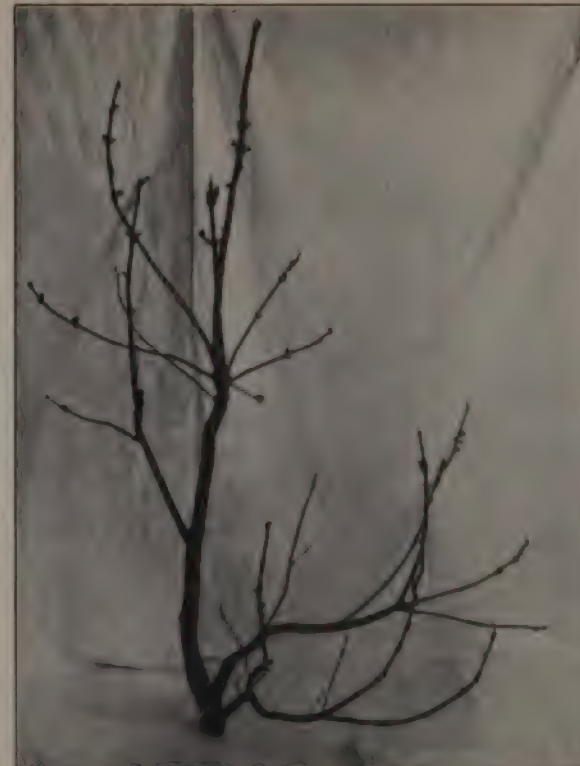
2.

WORK OF CATALPA BUD MAGGOT

(After Houser, courtesy O. Agr. Expt. Sta.)

PLATE 2

1.



2.

WORK OF CATALPA BUD MAGGOT

(After Houser, courtesy O. Agr. Expt. Sta.)

follows: First stage, four days; second stage, two days; third stage, three days; fourth stage, four days, and fifth stage, five days. Total, eighteen days.

The same insect in New York, as has been determined by Slingerland, requires from thirty to thirty-three days for its nymphal development. There is then a difference of two weeks in the time of development of the grape leaf-hopper in New York and that of the same insect in California. This difference is generally attributed to climate, although there is little difference between the climate of upper San Joaquin Valley in California in June and July and that of New York in the same months.

During the last week in June the hoppers, arising from the eggs of the over-wintering hoppers laid in May, begin egg laying, which is continued through July and a part of August. The incubation period was noted for a hundred or more eggs and they all hatched in from eight to twelve days. This is a shorter period than was required for the eggs to hatch in May from the over-wintering insects, and may be due to the difference in temperature.

A number of hoppers were confined in individual breeding cages on the leaves of the grape, and the number of eggs laid varied from forty to one hundred and twenty-one, distributed over a period of from three to seven weeks.

Hoppers hatching from these eggs remain on the vine until the leaves fall, when they attack their winter food plants, which include a large number of plants that may be growing in the vineyard or vicinity. These attack the vine in the spring, begin egg laying in May, and die off in July, making the length of the life cycle approximately one year. The spring brood hatching in May lives until about August or September, thus completing the life cycle in three or four months. There are thus two broods of the grape leaf-hopper in California, and, at least during the past year, there was no indication of a third brood.

NOTES OF THE SEASON

By H. A. Gossard, *Wooster, Ohio*

The season opened with a noteworthy weather condition that seems to have had a perceptible effect on the development of San José scale. March 19 the mercury rose to 68° at Wooster, and the following maximum temperatures were recorded at this place during the next two weeks:

March 19, 68°; 20, 67°; 21, 67°; 22, 82°; 23, 79°; 24, 74°; 25, 67°; 26, 70°; 27, 68°; 28, 67°; 29, 77°; 30, 67°; 31, 46°.

April 2, the mercury was down to 15°, and with the exception of seven nights, descended below freezing each night, until the 28th, when a warmer period commenced. However, the mercury dropped to the freezing point, or below it, nine nights in May, the last freezing record being on the 28th. Unfortunately, no direct observations were made which definitely proved this weather condition to have been adverse to the scale, but for some reason the scale has not been very much in evidence the past summer in many orchards that promised a year earlier to develop severe infestation in the normal course of events. Because of this phenomenon, I have not felt warranted in drawing conclusions regarding the effectiveness of one of the proprietary sprays which I undertook to test. The most plausible explanation occurring to me to account for this condition, is to suppose that the extended warm period in March started the dormant scales into activity, and that the cold freezing weather of April, following this warm period, proved fatal to them.

Some districts in which the scale has been controlled for three or four years with lime-sulphur spray, but were originally badly infested, are now seriously attacked and threatened with destruction by the bark borer, *Scolytus rugulosus*. I saw one orchard of young trees four or five years old which had never been very scaly, that was being badly attacked by these borers, which had migrated from a nearby apple orchard that had been destroyed by scale. This orchard seemed a good illustration of this insect's disposition to attack healthy trees when its numbers have outrun the supply of available weakened trees. As a trial application, I recommended to several correspondents to boil a thick lime-sulphur wash, using 20 pounds of sulphur and 30 pounds of lime, and add to each 50 gallons of this mixture 3 pounds of arsenate of lead (or 1 pound of paris green) and 6 to 10 pounds of fish-oil soap. This application was applied to the trunks and larger limbs with a spray pump or brush. Some of the parties who used it report seeming benefit, but I have not yet had an opportunity to make personal inspection of results, and shall not feel warranted in drawing any conclusions until the test is extended over several seasons. One orchardist painted the trunks and limbs of his trees in early spring with *Carbolineum avenarius* and the benefit against the borers was apparent. I inspected the trees in early July and, at that date, no great amount of injury to the trees from the application was perceptible, the counterbalancing benefits seeming to entirely outweigh the attending damage.

The spring opened very late, so that the first spraying for codling moth fell about the first of June in northern Ohio. This period was very wet and quite cool. For test work, I made use of a ten-acre orchard located about ten miles from the shore of Lake Erie, and hence not damaged much by frost. One half of this orchard consisted of Baldwins and the other half of Ben Davis. I tested the coarse, driving spray, as used in the western arid states, by enlarging the orifices in Vermorel nozzles, and also used the medium caps for comparison. Three pounds of arsenate of lead were used in 50 gallons of Bordeaux—the Bordeaux formula being 3 pounds of copper sulphate and 6 pounds of lime. The trees averaged 20 feet, or more, in height, and had a corresponding spread of top. One plot was treated with one third pound of paris green to 50 gallons of Bordeaux. About one gallon of soft home-made soap was added to each 50 gallons of spray for most of the plots. One plot had 2 pounds of copper sulphate and 1 pound of iron sulphate instead of the regular Bordeaux formula. About 100 pounds pressure was maintained by the pump. For the purpose of better directing the spray, two small pieces of three-fourths inch gaspipe, about 4 inches long, were threaded at each end. and after being bent about 25 or 30 degrees from the horizontal, one was attached to the end of each rod by means of a gas coupling, and the nozzles were then attached to the bent pipes. The spray was directed downward and inward and was used until the trees dripped. On trees 20 to 25 feet high, with corresponding spread of top, from 7 to 8 gallons of spray were used. The second spraying was made about 10 days after the first, and in the same proportions. only the copper sulphate was reduced to 2 pounds for 50 gallons of spray. Not more than one half as much spray was used in this application as in the first spraying. The third spraying was given to part of the orchard about the middle of July. Arsenate of lead alone was used for the July application. the Bordeaux being omitted. Not more than three or four gallons of spray were used on the largest trees for this application. As the full results of the test will soon appear as a Station publication. I will not enter into further details, but state results and conclusions. Over 90% of the apples on trees sprayed three times were free from worms. A record was kept of the dropped apples under certain trees beginning with the 30th of July. The following are some of the figures:

One tree sprayed twice. once just after blooming and again ten days later, has the following record: Sound apples dropped from the middle of July until harvest. 319; wormy drops from middle of July until harvest, 23; drops marked by curculio during the season, 8;

sound apples picked for harvest, 4,477; wormy apples picked for harvest, 14; marked by curculio at harvest picking, 21. Thus 98.67% were untouched by either codling worm or curculio; 99.25% were untouched by codling worm, and 99.69% were free from codling worm at harvest time. An unsprayed check tree, with a far better record than some others for sound fruit, yielded at the harvest 1,670 sound apples, 347 wormy ones, and 210 marked by curculio. Some of the wormy apples were also marked by curculio, which are not shown in this enumeration. Since the middle of July, this tree dropped 221 sound apples, 339 wormy ones and 48 marked by curculio. The season's yield, drops and harvest, gave 25.62% damaged by codling worm and curculio combined; 19% by codling worm alone, and 20.77% were wormy at picking time.

I decided that ordinary Vermorel nozzles with medium caps gave the best spray at 100 pounds pressure, and that the little crooks were of decided advantage in directing the spray; that three sprayings gave better results than two; that the first application just after blooming should be heavy to secure immunity from worm attack; that in cold, wet seasons, such as the past spring, considerable russeting follows a heavy spraying; that less russeting occurs on fruit sprayed when it is a week or ten days old than when it is younger; that russeting would probably be reduced by omitting Bordeaux from the first application, using instead arsenate of lead with lime added, but this question needs further testing; that an application for the second brood should be made by July 15th, or earlier in northern Ohio; that soap, or other stickers, do not appreciably enhance the value of these sprays when used on apples; that at least one pound of iron sulphate can replace one pound of copper sulphate in a 3–6–50 Bordeaux formula without injury to foliage or fruit, but I have not yet decided as to whether this mixture is an improvement on the ordinary Bordeaux.

The variegated cutworm, *Peridroma saucia*, was quite destructive in some localities, and if conditions are not unfavorable for its development, it will probably do a large amount of damage the coming year, for it is very plentiful over all northern Ohio. It attracted special notice at Sandusky, where it had attacked gardens, lawns and greenhouse products.

The radish maggott, *Pegomyia brassicæ*, was not so destructive as in some former years. I have not made very satisfactory progress against this pest, though I have, through two seasons, tried about all the known remedies. Mr. Geo. E. Hartung of Sandusky, a market gardener, who has suffered much from the insect in former years, reports practically no injury this season, and believes his immunity was

secured by overhead irrigation, since his neighbors suffered as in other years. Mr. Hartung's pipes are about 8 feet above the ground, 36 feet apart and the jets from the pipes are 4 feet apart. This result, and the attendant benefits of irrigation, seem to make this treatment worthy of testing by large market gardeners. For the ordinary kitchen garden, the most satisfactory treatment tried by me, from the view-point of good, healthy radishes, reasonably free from maggots, was a liberal application of tobacco dust every five or six days during the growing period, commencing as soon as the plants were through the ground.

The Hessian fly has dropped so nearly out of sight that careful search must be made to find it at all. I have not observed the chinch bug and only one or two correspondents have referred to it during the season. The wheat joint-worm has also decreased in numbers, not having been the subject of one half as many inquiries as were received regarding it last year.

The grape-berry worm has decreased considerably in the grape region along the lakes, but has become more injurious in the interior sections where the small, home vineyards are found. I repeated the experiments recorded in Circular 63, getting practically the same results. We used a traction sprayer fitted with 10 nozzles and throwing about 170 gallons of spray per acre. A double application with this machine—the Wallace—was very nearly equal to thorough hand work. A check row that was sprayed three times with Bordeaux, containing no poison, had 58% of the berries wormy and yielded marketable fruit at the rate of 1,798 pounds per acre. One-half of this check row was sprayed during the latter part of July by hand, with arsenate of lead in Bordeaux, with a resin soap sticker added, and this half of the row had 2.9% of wormy berries and yielded marketable grapes at the rate of 5,608 pounds per acre. This plot had the lowest percentage of wormy berries of any in the tests, but lost too many young grapes in the early part of the season to equal in total harvest some of the plots that received earlier applications of poison. This plot proved, however, that the late July spraying is the most important of all, and that the later broods of the worm must be killed or comparatively little benefit will be derived from the earlier applications. This result is a repetition of the experience of last season regarding late spraying. A plot, hand-sprayed three times with Bordeaux, arsenate of lead, and resin soap sticker, had 3% of wormy berries and yielded at the rate of 6,031 pounds of marketable grapes per acre. The grapes of this plot had too much spray adhering to them at harvest time, and it will be necessary to sacrifice some grapes

rather than to send them to market in this condition. A plot sprayed three times with the same ingredients, by the double machine plan, had 4.47% of wormy berries and yielded 6,067 pounds of marketable grapes per acre. Three sprayings of Bordeaux, with arsenate of lead and resin soap added to the second and third applications, double machine plan, gave 4.8% wormy berries and harvested 3,864 pounds of marketable grapes per acre. The same ingredients applied at the same time as in the preceding case, but with single machine instead of double machine application, gave 20.34% wormy berries and harvested 3,465 pounds of marketable grapes per acre.

The double machine applications, if made three times with soap stickers, gave almost as good results as hand sprayed plots and were more presentable for market. It is quite conceivable, however, that if little rain were to fall in late summer, grapes treated in this way might carry too much spray to be presentable in appearance or safe to use in large quantities at harvest time. One plot was treated with a Bordeaux made of 4½ pounds of copper sulphate, 3 pounds of iron sulphate and 6 pounds of lime, with 3 pounds of arsenate of lead added. This made a spray that had good sticking qualities and yet washed off quite readily by rain. Three sprayings, double machine application, with this mixture, gave 10.18% wormy berries and 5,760 pounds of marketable grapes per acre. This treatment seemed quite satisfactory for the fruit, but threatened to eat the galvanizing from the iron wires supporting the vines, thus shortening their durability by more than half. Parasites are appearing freely over the infested vineyards and doubtless are contributing to the suppression of the worm.

The greenhouse white fly has become established in many greenhouses and we have a good many inquiries regarding the process of fumigation with hydrocyanic acid gas. The fall webworm was abundant last year, but has been much more numerous the present season. Park superintendents and many orchardists have been obliged to wage systematic warfare against it the past summer. The black walnut caterpillar, *Datana integerrima*, has been numerous for two seasons, and many trees are threatened with destruction by it, having been completely defoliated for two years in succession. The white-marked tussock moth has been extremely abundant in city parks and was the subject of many inquiries. *Pimpla inquisitor* has become numerous at Dayton, according to local observers, and the suppression of the tussock worms is expected in that city in a short time. The terrapin scale, *Eulecanium nigrofasciatum*, has been our most serious scale insect on maple trees for the past two seasons. The remedies usually recommended for this scale—namely kerosene emulsion and the lime-

sulphur wash in winter—have not given very good results where tried by the Station.

A rather extensive test against the peach borer was tried in a young orchard, but partially failed to yield results because of the scarcity of borers, even on the check trees, and of course full returns cannot be had until spring. I decided, however, that the use of building paper, or other protectors of like character around the trees for a period sufficiently long to be of effectual use in preventing egg-laying, was more undesirable than injury by the borers, while various sticky and poisonous mixtures were of questionable utility. Mounding with earth seemed among the best remedies, but by all odds the most satisfactory treatment from the standpoint of the trees and borers combined, was tying tobacco stems loosely about the base of the trunk, and suspending them from a point about twelve or fifteen inches above the ground. Prof. Slingerland gave a very good report of this treatment several years ago, but did not specially emphasize the splendid tonic effect it exercises on the trees. This treatment seemed to more than pay for itself without any reference to the presence of borers, while at the same time it possessed good value in this respect.

In 1906 I took advantage of the proffered services of Mr. C. F. Harbison of Dayton, O., to conduct a coöperative experiment against the elm leaf-beetle. Acting under my instructions, Mr. Harbison banded some elm trees in early June with Thum's Tree Tanglefoot to prevent the larvæ reaching the ground when descending to pupate. Immediately above this sticky band was arranged a burlap band, beneath which the insects could shelter and pupate. The first count of the catch was made June 17, and showed 200 insects in the Tanglefoot band, 124 beneath the burlap and 72, which had been dislodged, at the base of the tree and were unable to re-ascend. This made 396 in total.

A second examination made June 21, collected 417; a third, 599, and a fourth, 422, making 1,834 beetles, pupæ and larvæ taken from one tree.

About July 24th, eight trees were banded and the totals taken during the four examinations amounted to 16,122 insects in various stages, mostly larvæ and pupæ. The number under the burlap band that had pupated kept constantly increasing at each examination, indicating the importance of the burlap in connection with the Tanglefoot. The same experiment was repeated the past year and Mr. Harbison reports a collection of 4,938 insects from three trees on the 9th of August; again, on August 13th, 8,491 insects from four trees; and on August 22d, 4,653 insects from three trees, making 18,082 insects from ten trees. I do not understand from the report whether the bands

were put on all of these trees on the same date or not, but this is my inference. Mischievous persons, presumably boys, removed the bands before further examinations could be made, but we regard this method of fighting the insect as proved to be cheap and effective.

A Millipede, one of the *Polydesmidæ*, became very numerous in the Station greenhouse this fall, occurring by tens of thousands in a bed devoted to forcing cucumbers. A few vines were killed before the insects attracted notice. The men in charge used a plentiful supply of tobacco dust as a mulch about the bases of the vines, and also mixed more or less of the dust in the soil, with the result that hundreds of dead worms could be found at the base of each vine a few days after the application was made, and tens of thousands of them dropped from the beds to the stone floor beneath, where they died. This remedy was a speedy and complete success.

In my bulletin on insecticides, published by the Florida station, I mentioned the use of powdered cyanide of potassium for ants, in cases where carbon bisulphide could not be conveniently used. This has been used so successfully by some parties to whom I have recommended it the past summer, that I think it worth while to emphasize the value of the treatment. The crushed cyanide must not come in contact with plant tissues, but should be sprinkled on the soil where the ants congregate, or have their nests. The ants either leave at once or attempt to remove the obnoxious particles, only to die in the attempt. The cyanide, if used in moderation, will act as a fertilizer for the plant and benefit instead of harming the same.

The Rosebug was abundant at Wooster, as has been the case for the past three seasons, and the vilest sprays do but little good against it. I have succeeded in driving them away for a day or two by spraying with Bordeaux mixture, to which was added arsenate of lead, fish-oil soap and crude carbolic acid, but they were always ready to return after a few hours' interval. The larger the area sprayed, the less heed do they seem to give the treatment. I found it practicable to fence them out from a few blooming grapevines with a covering of mosquito bar, and also that they could be prevented from accumulating and doing any great amount of injury by picking them by hand three times a day through a two weeks' period. Though the latter method was only tried on a small scale, I am inclined to think it would pay in commercial vineyards of small size, at least in seasons where fruit is as high priced as at present.

During the spring, wheat and oats over Ohio suffered from a peculiar disease, marked by a reddening, yellowing and browning of the leaves, and a general stunting of the growth and retardation of the

development in all respects. From the fact that the grain louse, *Macrosiphum granaria,* was noticed in considerable numbers in some fields, the newspapers and many correspondents attributed the damage to the lice. Others suspected thrips of causing the mischief. After an examination which I deemed adequate, I concluded that neither of these insects was primarily responsible for the disease so far as Ohio was concerned, though both species added to the trouble to a considerable degree in some fields. The majority of the diseased plants, however, were damaged but little by either insect, and many of them not at all, so far as I could determine. Corn, clover, alfalfa, strawberries and many weeds suffered in precisely the same way, as inferred from their external symptoms, and no insects whatever could be found upon them. I decided the trouble was probably wholly physiological in character, and was in all likelihood caused by the cold, wet spring. Parasites overtook the lice in most localities before they became excessively plentiful.

THE HONEY AND POLLEN-YIELDING PLANTS OF TEXAS.

By A. F. Conradi, *Clemson College, S. C.*

Triple-leafed Barberry. (*Berberis trifoliata* Moric.) On gravelly hills from the Gulf coast to the Limpia mountains. Yields honey abundantly, also pollen. Blooms January and February and is important for early brood rearing.

Prickly Poppy. (*Argemone platyceras* Link and Otto.) Abundant along roadsides, in waste fields and on prairies. Honey yield unimportant, but yields abundant pollen during dearth of summer. In the Brazos River Valley bees work heavily on it during June. The orange-colored pollen is carried to the hive, making the combs look disagreeable. May to July.

Poppy. (*Papaver rhœas* L.) Honey yield unimportant owing to scarcity of plants. May.

Pepper wort. Pepper grass. (*Lepidium virginicum* L.) Widely distributed. Yields small quantities of honey and pollen.

Greggia. (*Greggia comparum* Gray.) Confined largely to west Texas. Blooms near San Antonio in February. Yields some honey, but pollen is important for early brood rearing.

Turnip. (*Brassica rapa* L.) Yields honey and pollen.

Black mustard. (*Brassica nigra* (L.) Loch.) Scatteringly throughout Texas. Bees work on it busily, but its status as a bee forage plant has not been determined. June and July.

Portulaca grandiflora Hook. Grown in experimental plats at College Station. Honey yield good owing to the extended blooming period from June till frost. Pollen is highly colored.

Salt cedar. (*Tamarix gallica* L.) Common in the Gulf coast country. Several trees cultivated at College Station bloom from May to June.

Fringed Poppy-mallow. (*Callirhoe digitata* Nutt.) A common plant yielding honey and pollen in small quantities. An excellent pollen plant at College Station.

Spanish Apple. (*Malvaviscus drummondii* Torr. and Gray.) Common along the Comal and Guadalupe rivers near New Braunfels. Bees visit it, but in that section is not an important honey plant.

Shrubby althea. (*Hibiscus syriacus* L.) An ornamental plant in parks and gardens. Bees work busily on it, but the plants are few. Yields honey and pollen; blooms from May and June to fall.

Sida spinosa L. A common plant blooming during the summer. Honey and pollen yield light, but valuable during dearth.

Sida angustifolia Lam. In dry soils throughout southern Texas blooming from spring to fall. Yields honey and pollen.

Cotton. (*Gossypium herbaceum* L.) Yielding a strong steady flow of white honey during the entire blooming period from June to frost. The main source of honey throughout the cotton section. The honey is furnished by nectar glands of leaves, bracts, blossoms and bolls.

American linden. (*Tilia americana* L.) Occurs sparingly throughout Texas as far west as San Antonio. A heavy yielder of fine honey.

Large-flowered caltrop. (*Tribulus cistoides* L.) Mr. L. Scholl reports this plant from Hunter as a good honey and pollen yielder, but flowers close at noon. April to August.

Greater Caltrop. (*Kallstroemia maxima* (L.) T. and G.) Common throughout southern and western Texas; a good honey and pollen plant in time of dearth.

Yellow wood sorrel. (*Oxalis stricta* L.) In open woodlands throughout Texas, blooming during summer, but not abundant enough to be important bee forage.

Prickly ash. (*Xanthoxylon clava-herculis* L.) Known as toothache tree and sea-ash. A common shrub in woodland prairies, blooming April 15 to June. A good honey and pollen plant.

Hop tree. (*Ptelia trifoliata* L.) In low woodlands throughout southern and western Texas. Where abundant the plant is a good honey yielder during favorable seasons. May to July.

Hardy orange. (*Citrus trifoliata* L.) Until recently this plant

has been scarce in Texas, having been planted principally for hedges. With the development of the citrus industry the demand for hardy deciduous stock to enable the commercial orange tree to withstand a lower temperature has caused a rapid increase of this species. It blooms March 15 to 25; during this time bees work on it busily, obtaining a fair quantity of honey for early brood rearing.

Tree of Heaven. (*Ailanthus glandulosa* Desf.) This is recorded from Hunter as follows: Cultivated for shade. Honey yield fair in good seasons, also pollen. There are also nectar glands on leaf blades. April.

Umbrella china tree. (*Melia azedarach* L.) A common shade tree in central and southern Texas. It yields honey which helps early brood rearing in February and March.

Possum Haw. (*Ilex decidua* Walt.) Also known as Youpon and Bearberry. Lowlands in southern and central Texas west to the semi-arid country. Blooms between March and May. Valuable for early brood rearing.

Youpon. (*Ilex caroliniana* Trelease.) Southern Texas westward to San Antonio. March and April, helping early brood.

Brazil wood, Log wood. (*Condalia arborata* Hook.) Central and western Texas. A good honey plant at College Station; some pollen. July and August.

Colubrina texensis Gray. On dry soils from the Colorado River west and south. Honey yield good; some pollen. Plants too scarce for surplus. April.

Rattan vine. (*Berchemia scandens* Trelease.) Along ravines and in lowlands; blooms April 15 to 25, giving a good surplus in favorable seasons, but the honey is dark amber.

Common grape vines. Good for pollen. April.

Mountain grape. (*Vitis monticola* Buckley.) Hilly limestone regions of western Texas. Honey yield fair; pollen valuable for early brood rearing. March.

Cow itch. (*Cissus incisa* Desmoul.) On uncultivated ground from the Colorado River westward. April to August, yielding surplus where plentiful.

Soap berry, Wild china. (*Sapindus marginatus* Willd.) Creek bottoms throughout southern and western Texas. An evergreen shrub, blooming in April and May, yielding heavy surplus where the plants are abundant.

Balloon vine. (*Cardiospermum halicacabum* L.) Throughout central, southern and western Texas. Honey yield good, but plants are scarce.

Mexican buckeye. (*Ungnadia speciosa* Endl.) In mountainous woodlands and on rocky hillsides throughout southern, central and western Texas. Honey yield important as it blooms during July dearth, but the plants are not plentiful.

Green Sumach. (*Rhus viviens* Lindh.) In rocky country west of Colorado River. Bees work on it during dearth. Blooms as late as October.

Rhus sp. A small shrubby tree on rocky hillsides and on woodland prairies. Bee-keepers report it a good honey plant, giving surplus in favorable seasons, depending upon rains. August.

Blue bonnet. (*Lupinus subcarnosus* Hook.) Southern, central and western Texas on prairies and on open woodlands. The honey and pollen yield is good; the pollen is of a bright orange color. March and April.

Red clover. (*Trifolium pratense* L.) An attempt was made to grow red clover with a view of determining the ability of the five races of bees to secure honey, notwithstanding the deep corollas. We have no evidence that any of the strains of bees are able to obtain honey, while the plants did not prosper owing to the dry climate.

Alfalfa. (*Medicago sativa* L.) Is extensively cultivated for hay in humid and semi-arid Texas. We know that it is a valuable honey plant in irrigated sections of Colorado and New Mexico, but there is considerable difference of opinion as to its value in unirrigated sections of Texas. In the great honey belt of southwest Texas it appears to be no preferred plant. We have a note on record from Mr. E. Scholl, formerly assistant to the writer, when State Entomologist of Texas, which states that large numbers of bees were seen on alfalfa at New Braunfels during June, 1907. During his work as deputy foul brood inspector he reports alfalfa "a good thing" in north Texas. In the Brazos River bottom where bees were near alfalfa we were unable to ascertain the importance of alfalfa as a honey plant because bees preferred other blossoms occurring during alfalfa bloom. Where bees work on it, the honey yield is fair during early summer and fall. On July 12 Mr. Will Atchley, one of the most successful apiculturists of Texas, presented the writer with a jar of alfalfa honey from Beeville, the quality of which was fully equal to the Colorado product.

Medick, Burr clover. (*Medicago denticulata* Willd.) Abundant at College Station during spring. While it yields honey sparingly during early summer, it comes into bloom at a time when honey flora is scarce, and when bees must depend on honey gathered from mis-

cellaneous sources. It disappears with the approach of hot weather and the advance of Bermuda grass.

White sweet clover. (*Melilotus alba* Seso.) Sparingly scattered along railroad tracks and in waste places. It is a good yielder of a fine quality of honey. The plants cultivated in the experimental plats at the A. & M. apiary are doing well each season. Seeds scattered broadcast in waste grounds germinated well, but the young plants were seriously handicapped by the ever-present and persistent Bermuda grass. Mr. C. S. Phillips of Waco, Texas, stated to the writer that sweet clover sown by him along the H. & T. C. Railroad near Waco appeared to hold its own. The plants bloom from June to fall. Owing to its honey yield white sweet clover should be sown for honey producing purposes. It grows in soils containing lime and although cattle treat it with skepticism when first introduced to it, owing to the characteristic odor, they soon learn to eat it. In cultivated land and where Bermuda grass is absent the plant prospers. No doubt every bee-keeper could utilize it to supplement the honey flow during a season of dearth. The writer has observed this plant in several latitudes between the Rio Grande River and northern New England where "bees roared on it."

Yellow sweet clover. (*Melilotus officinalis* (L.) Lam). Occurs sparingly, escaped. Bee-men contend that yellow sweet clover is earlier and superior to white sweet clover. It should be cultivated on waste lands and the poorer soils. May to fall.

Eysenhardtia. (*Eysenhardtia amorphoides* H. B. K.) Also known as rock brush. On light soils of woodlands and open prairies throughout southern and western Texas. Yields abundant honey of a fine quality. March to May after heavy rains.

Black locust. (*Robinia pseudacacia* L.) Cultivated occasionally on lawns. During March and April the bees work on it abundantly, obtaining a fair quantity of honey, provided the weather is not too cold.

Mexican ground plum. (*Astragalus americanus* A. D. C.) Open prairies of Texas, yielding honey abundantly, principally during June. It is injured by drouth.

White clover. (*Trifolium repens* L.) Sparingly on roadsides and lawns. It is well known as one of the main sources in states north of Texas. Several attempts to grow it at College Station proved failures owing to dry climate.

Cow pea. (*Vigna* sp.) Cultivated for forage and soil improvement. July and August. Yields a good quantity of light-colored honey of fair quality. It is one of the plants utilized at the experi-

mental apiary for bridging the bees from spring flora to horse mint and cotton, but the repeated cold waves during the spring of 1907 severely handicapped its honey yielding power.

Neptunia. (*Neptunia lutea* Benth.) Sparingly, eastern and southern Texas along the Rio Grande as far north as Laredo. Pollen during May.

Red bud, Judas tree. (*Cercis canadensis* L.) Our only honey-producing records are from Comal County, where it blooms from March 1 to April 15. Good honey plant, helping early brood.

Sensitive briar. (*Schrankia angustata* Torr. and Gray.) Open prairies west of San Antonio. Honey yield not important owing to the scarcity of the plant, yielding pollen. April to September.

Cassia. (*Cassia longifolia* Car.) In damp sandy places; visited frequently by bees.

Mesquite, Screw bean. (*Prosopis juliflora* D. C.) Widely distributed in southern and western Texas. While occurring sparingly everywhere in Texas, the mesquite belt proper extends from the Rio Grande River north to the northern tier of counties of the Pan Handle, between 98 and 101 meridians, and along the valleys of the Rio Grande, Pecos and Canadian rivers. Main source in State. Honey light colored. April and again in June.

Honey locust. (*Gleditchia triacanthos* L.) Sparingly wild and in cultivation. Heavy yielder at College Station, but bloom extends from April 15 to 25 only.

Garden pea. (*Pisum sativum* L.) Yields some honey and pollen.

Retama. (*Parkinsonia aculeata* L.) Low sandy soils, southern and western Texas. May to September. Valuable in dearth.

Albizzia. (*Albizzia julibrissin* Durazz.) On campus, College Station; honey yield fair. May to July. Long stamens handicap bees.

Huajilla. "Wahea." (*Acacia berlandierei* Benth.) Solid masses on dry and rocky hills from the Nueces to the Rio Grande and Devils rivers; at its best in Uvalde and adjoining counties. Heavy honey yielder; best honey in State and main surplus in southwest Texas.

Cat claw. (*Acacia gregii* Gray.) Also known as devil's claw and Paradise flower. On dry, rocky soil throughout southwest Texas. One of the main yielders of fine honey. April and again in June.

Texas cat claw. (*Acacia wrightii* Benth.) Throughout southwest Texas; one of the main yielders of fine honey. April.

Round-flowered cat claw. (*Acacia roemeriana* Schlecht.) Widely distributed over southwest Texas, yielding a heavy flow of fine honey during April and May. Less abundant than preceding species.

Acacia. (*Acacia amentaceae* D. C.) Abundant throughout south-

west Texas on prairies. Not very important for honey, but an excellent pollen plant in early summer when bee forage is scarce.

Huisache. (*Acacia farnesiana* Willd.) Abundant from San Antonio southward throughout the Gulf coast country. A good honey yielder and excellent for stimulating early brood. Yields pollen. February, March and April.

Plum. (*Prunus domestica* L.) Honey yield good. Valuable for early brood. February to March.

Wild plum. (*Prunus cerasus* L.) Abundant in waste places throughout the humid sections. February to March. Valuable for early brood.

Bridal wreath. (*Spiræa virginiana* Britt.) Ornamental shrub; helps early brood.

Dewberry. (*Rubus trivialis* Mx.) Wild low bush blackberry. Yields honey and pollen in April. Widely distributed.

Hawthorne, White thorn. (*Crataegus arborescens* Ell.) Moist ground southern and western Texas west to Colorado River. Good honey and pollen plant. April.

Rose. Blooms throughout season. Good for pollen.

Apple. (*Malus malus* (L.) Britt.) Scarce. Yields honey March 15 to April 10. Helps early brood.

Peach. (*Amygdalis persica* L.) Widely cultivated. Valuable in building up colonies in spring. February to April.

Evening primrose. (*Jussiaca diffusa* Forskl.) Wet places eastern and central Texas. June to middle of August, and where abundant it is very important during drouth.

Gaura filiformis Small. Sandy soils of central Texas, yielding surplus in seasons of sufficient rain.

Musk melon. (*Cucumis melo* L.) Widely cultivated. Good honey and pollen plant. Early summer to fall.

Prickly pear. (*Opuntia engelmannii* Salm. and Dyck.) Common, southwestern Texas. Heavy honey yielder, sometimes giving surplus. Bee-keepers report that when honey is first stored it is of a rank flavor. May to June.

Dogwood. (*Cornus asperifolia* Mx.) Sparingly in low lands, eastern and central Texas. Favorite with bees and honey yield good, but not very heavy. March to April.

Elder. (*Sambucus canadensis* Linn.) Sparingly in moist places throughout Texas; a good honey plant. April and May.

Coral berry. (*Symphoricarpas symphoricarpos* L.) Along wooded streams near College Station. Blooms July to September and is a good honey plant.

Cucumber. (*Cucumis sativus* L.) Cultivated. Good honey plant, but scarce and of short duration.

Pumpkin. (*Cucumis pepo* L.) A better pollen than honey plant. May to June.

Watermelon. (*Citrullus citrullus* (L.) Karst.) A good honey and pollen plant; at its best on dewy mornings. Blooming period extends over the greater portion of the summer until frost.

Wild gourd. (*Cucurbita foetidissima* H. B. K.) Scatteringly, southern and western Texas. Honey flow light; better for pollen. April to July.

Black haw. (*Viburnum rufotomentosum* Small.) Woodlands of central and western Texas. Good honey yielder early in season and valuable for early brood.

Bush honeysuckle. (*Lonicera fragrantissima* Lindel.) A small bush cultivated on the campus at College Station. Earliest honey yielder of the locality, furnishing honey as early as January. Valuable for early brood in mild winters.

White-flowered honeysuckle. (*Lonicera albiflora.*) Recorded from Hunter, Texas, blooming from May to July. A good honey plant but scarce.

Houstonia angustifolia Mx. Dry soils throughout Texas. May to July. Bees work well on it, but plants are scarce.

Button weed. (*Diodia teres* Walt.) Low sandy soils of Texas. Not a heavy yielder, but important in July and August where horsemint and cotton is not heavy.

Button bush. (*Cephalanthus occidentalis* L.) In moist soils throughout Texas. Bees work on it during July.

Goldenrod. (*Solidago* spp.) Throughout Texas. Abundant in late fall, but unimportant where broom and bitter weed is abundant.

Roman wormwood. (*Ambrosia artemisiifolia* L.) Common on dry uplands, yielding pollen.

Tall ragweed. (*Ambrosia aptera* D. C.) Low soils throughout southern and western Texas. July and August, yielding adhesive pollen.

Great ragweed. (*Ambrosia trifida* L.) Moist land, central and eastern Texas. July and August. Good for pollen.

Cockle burr. (*Xanthium canadense* Mill.) Common in river bottoms, yielding pollen in September and October.

Common sunflower. (*Helianthus annuus* L.) Common in waste fields. Good honey yield, but strong flavored. Yields propolis.

Sneeze weed. Bitter weed. (*Helenium tenuifolium* Nutt.) Common in open waste places of eastern and central Texas. Yields honey

and pollen. The honey is bitter as quinine, but owing to its long-continued blooming period from June to frost, it is an important plant for winter stores.

Marigold. (*Gaillardia pulchella* Fang.) Common throughout Texas. Yields surplus. Honey dark amber. May to June.

Dandelion. (*Taraxicum officinale* Weber.) Common. Yields some honey of strong flavor.

Blue thistle. (*Cnicus altissimus* Willd.) West to Guadalupe River. July and August. Bees work on it heavily at times.

Parthenium. (*Parthenium hysterophorus* L.) In waste places throughout Texas. April till frost, yielding honey and white pollen.

Broom weed. (*Gutierrezia texana* T. & G.) Open prairies throughout Texas. Honey dark and of strong flavor. Important for winter stores. September and October.

Texas persimmon. (*Diospyros texana* Schule.) Woodlands and ravines, southern and central Texas. Good honey yielder. April and June.

Common persimmon. (*Diospyros virginiana* L.) West to Colorado River. A good honey plant but scarce. Blooms a little earlier than *D. texana.*

Gum elastic. (*Bumelia languinosa* Pers.) Woodlands, eastern and southern Texas. Good honey plant, but blooming period short. June 25 to 30.

Privet. (*Ligustrum vulgare* L.) A good honey plant, but flowers scarce owing to annual trimming.

Milkweed. (*Asclepias* sp.) Good honey plant at Beeville, but pollen attaches to bee's feet and cripples them.

Dense-flowered Phacelia. (*Phacelia conjesta* Hook.) Common, blooming April to June. Some honey. *P. glabra* yields some honey.

Borage. (*Borage officinalis* L.) Cultivated at College Station. A good honey plant in June. Stalks die during drouth, but revive and bloom again later in season.

Morning glory. (*Ipomoea caroliniana* Prush.) Throughout eastern, central and southern Texas, blooming during summer, yielding a light flow of honey and pollen.

Night shade. (*Solanum rostratum* Duval.) Yields some honey and pollen from May to October.

Trumpet creeper. (*Campsis radicans* L.) Humid sections of Texas. Honey yield light; pollen from external nectar glands and stems of flowers.

Fog fruit. (*Lippia nodiflora* L.) Honey yield light during July.

White brush. (*Lippia ligustrina* Britt.) Abundant in southwest

Texas. Blooms May to September, yielding a heavy honey flow of fine quality.

French Mulberry. (*Callicarpa americana* L.) Abundant in rich soils of central and southern Texas, yielding honey.

Salvia. (*Salvia roemeriana* Sch.) Yields honey during summer in western Texas, but bees are handicapped by deep corollas.

Salvia azurea Lam. Throughout Texas, but corollas very deep. Visited by bumblebees. April to October.

Lantana. (*Lantana camara* L.) Yields some honey. April to October.

Virginia crownbeard. (*Verbena virginica* L.) In rich wooded lowlands of central, southern and western Texas. October. A heavy yielder of fine honey.

Blue vervain. (*Verbena officinalis.*) Throughout Texas. April to August, yielding a light honey flow through the season.

Catnip. (*Nepeta cataria* L.) Cultivated in the experimental plats at the apiary at College Station in 1904. The plants did not prosper; those that bloomed were visited by bees.

Wild bergamot. (*Monarda fistulosa* L.) Sparingly on dry soils of Texas. May to July. An excellent honey plant.

Horsemint. (*Monarda clinopodioides* Gray.) Waste lands of eastern and southern Texas. May 20 to June 20; an excellent honey plant, being one of the main yielders, the honey comparing favorably with that of basswood.

Horsemint. (*Monarda punctata* L.) Waste prairies, eastern and southern Texas. Abundant along railroad tracks; one of the main honey plants. May to July.

Common hoarhound. (*Marrubium vulgare* L.) Throughout the State; a good yielder of a dark amber-colored honey from February to mid-summer.

Drummond's skullcap. (*Scutellaria drummondii* Benth.) Throughout Texas; a good honey yielder in April and May.

Common pigweed. (*Amaranthus retroflexus* L.) Throughout Texas. Yields some honey and pollen July to September.

Spiny amaranth. (*Amaranthus spinosus* L.) Bees visit it, obtaining a small amount of pollen. August.

Buckwheat. (*Fagopyrum fagopyrum* (L.) Karst.) Cultivated. Our records are from College Station. Yields fair quantities of honey on dewy mornings, but is handicapped in dry atmosphere. We found it a very good plant to bridge dearths.

Mistletoe. (*Phoradendron flavescens* (Pursh) Nutt.) A parasitic

plant, growing on oak, elm, hackberry, and mesquite. Blooms from December to February. A good honey and pollen plant.

Spurge. (*Euphorbia marginata* Pursh.) Low lands of western Texas, yielding honey during summer and fall.

Sonora croton. (*Croton sonoræ* Torr.) Observed in Llano and Comal counties. Although honey flow is light, it comes during the July and August dearths.

Goat weed. (*Croton capitatus* Mx.) Central and southern Texas. Not important in bee sections, but valuable where the honey flora is scarce. At College Station it is a good pollen plant during August.

Texas croton. (*Croton texensis* Muell.) Western Texas. A light honey yielder during summer from June to August.

One seeded croton. (*Croton monanthogynus* Michx.) Central and southern Texas. May to June. Honey yield fair.

Castor-oil plant. (*Ricinus communis* L.) Cultivated throughout State; sparingly escaped. Honey and pollen yield good. Nectar glands at base of leaf. March and April.

American elm. (*Ulmus americana* L.) Low woodlands of central Texas. Good honey and pollen plant, sometimes yielding surplus. The honey is amber and characteristically aromatic. August to September. Also known as "wahoo."

Granjena. (*Celtis pallida* Torr.) Bee-keepers report it an important plant. We have no other records.

Hackberry. (*Celtis mississippiensis* Bosc.) Common in central Texas. Fair honey yielder and good for pollen early in the season.

Hackberry. (*Celtis occidentalis* L.) Cultivated for shade throughout Texas. Occurs in ravine at College Station. Fair honey plant and good pollen yielder. Valuable for early brood.

Osage orange. (*Toxylon pomiferum* Ruf.) Planted for hedges in humid sections. April. Yields honey but plants are scarce.

Hickory. (*Hicoria alba* L.) Common in sandy lowlands, yielding some honey and pollen in March.

Pecan. (*Hicoria pecan* Britt.) Cultivated and wild. Good for pollen. March.

Post oak. (*Quercus minor* Sarg.) Sandy soils, eastern and central Texas. Its quantities of pollen during March and April make it a valuable plant for early brood.

Black jack. Barren oak. (*Quercus marylandica* Muench.) In post oak woods. Yields pollen in early spring.

Live oak. (*Quercus virginiana* Mill.) Southern and western Texas. A good honey plant for early brood in March. Honey dark colored.

Red oak. (*Quercus rubra* L.) Westward to San Antonio. Yields pollen in March. Trees scarce.

Spanish oak. Pin oak. (*Quercus palustris* Duroi.) West to San Antonio. A good honey and pollen plant. Valuable for early brood.

Water oak. (*Quercus aquatica* Walt.) Moist soils, eastern and central Texas west as far as Austin. Pollen in early spring, but the plant occurs sparingly.

Black willow. (*Salix nigra* March.) Wet places. A good honey and pollen plant. Valuable for early brood. February to April.

Cotton wood. (*Populus deltoides* Marsh.) Low lands everywhere. Fair honey plant, but a better pollen yielder for early brood. March.

Cat briar. (*Smilax bona-nox* L.) Everywhere. Grows in thickets, yielding honey, but bloom of short duration. April 10 to 25.

Virginia spiderwort. (*Tradescantia gigantea* Rose.) Scatteringly on prairies. Yields some pollen for early brood.

Sorghum. (*Sorghum vulgare* Pers.) Cultivated for forage and hay. Yields honey, but it is particularly valuable for the abundance of pollen during June.

Indian corn. (*Zea mais* L.) Valuable pollen plant from May to June.

Silver berry. (*Elaeagnus argentia* Pursh.) Cultivated for ornamental purposes at College Station. The honey from the nectar glands runs down the long corollas where the bees can get it. Blooms in spring and fall.

Sweet olive. (*Elaeagnus angustifolia* L.) One bush at College Station. Honey yield good. April.

Firmiana platinifolia (L.) R. Br. Ornamental at College Station. Heavy honey yielder from May 10 to June 15.

Crepe myrtle (*Lagerstroemia indica* L.) Cultivated. Blooms June to October, bees working heavily at intervals.

While, upon examining the list of honey plants, it will be noticed that the heavy yielders are few, one or more species occur in all parts of the State. Bee-keeping can be carried on only where the honey flow is continuous when the bees are active. The many minor plants here recorded are of great value in keeping colonies in good condition during the intervals between the surplus yielders. In sections where dearths occur they may be bridged by cultivated species, provided the conditions of the locality are known so that the work can be planned with approximate accuracy. A great field is open in Texas for the distribution of honey plants for the purpose of producing a continual honey flow in sections where the bee-keeping industry is at present handicapped by dearths. By close observation bee-keepers should

soon learn what plants could be utilized for this purpose, employing either cultivated species or wild plants obtained from seed scattered in waste places.

FEDERAL PROTECTION TO AMERICAN AGRICULTURE AND HORTICULTURE FROM INVASION BY FOREIGN INSECT PESTS

By Jacob Kotinsky, *Honolulu, Hawaii.*

(Withdrawn for publication elsewhere.)

It was impossible to publish the following paper in regular sequence, owing to a failure to submit the manuscript in due time. The discussion relating thereto follows. Ed.

LIFE HISTORY OF THE STRIPED CUCUMBER BEETLE WITH A BRIEF ACCOUNT OF SOME EXPERIMENTS FOR ITS CONTROL

By T. J. Headlee, *Manhattan, Kan.*

In this paper it is purposed to give briefly the results of a study of the striped cucumber beetle, undertaken at the New Hampshire station for the purpose of clearing up certain doubtful points in its life history, its action under local conditions, and the practicability of the common remedial measures. Credit is due Prof. Sanderson for constant aid and encouragement.

Life History

Egg. In 1907 the first eggs discovered were laid by a caged beetle on July 2d, but it was not until July 16th that they were found in the field. Eggs were last taken in the cages the 7th of August, and oviposition in the field appeared to have ceased some time before. The egg-laying period, therefore, occupies about one month in New Hampshire.

The eggs are deposited singly or, with equal frequency, in groups, in the soil, usually just beneath the surface, but sometimes on the surface or, again, a considerable distance down. The variation seems to be largely dependent upon the compactness and moisture of the ground. When it was dry and cracked, the beetle was likely to deposit her eggs on the moist soil in some crevice, but if damp and com-

pact, she would deposit them in shallow crevices, or even right on the surface. The female certainly shows a preference for a crack or crevice as a place to deposit her eggs. She oviposits in the soil anywhere within a radius of five or six inches of the stem of the young plant. Although the eggs are frequently laid between the plant stem and the surrounding earth, we have found no evidence to show that this is a favorite place. In instances where oviposition was observed, and this happened to be on damp soil, she simply brought the tip of her abdomen down nearly or quite to the surface of the ground, and pushed the eggs out, or, finding a furrow, she crawled into it and deposited eggs on the sides and bottom.

Experiment has shown that while the eggs are generally deposited on moist soil, they can withstand some desiccation if again returned to moist conditions, but that they never hatch if kept continuously in a dry situation.

A dissection of 18 gravid females collected at different times from late June to September showed an average of only 33 well-developed eggs per individual, with the upper extreme as 59. Yet in the breeding-cages, five females produced an average of 88 eggs each, with 54 and 117 as extremes. The cage records indicate that, once the beetle begins to oviposit, she continues at frequent intervals until her supply of eggs is exhausted.

Careful records of 32 eggs show that an average of 8.75 days is required under an average mean temperature[1] of 74° F. with an accumulation of 653.8° F. (read) or 651.03° F. (measured) to bring them from deposition to hatching.

Inasmuch as recent studies point to the fact that each insect has a different critical temperature, no effort has been made to compute the effective temperature, but the amount given represents all the degrees above 0° F.

[1]The average mean temperature has been computed by (1) averaging the mean temperature of the days through which each egg passed before hatching, and then (2) averaging the average mean temperature of all the eggs. The mean temperatures of the days through which each egg passed were summed for each egg, and the average sum of the temperatures for all the eggs was taken as the sum temperature of the egg stage. Finding that the daily mean derived by measuring the irregular polygon made by the thermograph pen on the revolving record-sheet showed less variation, and hence was likely to be freer from the variation to which any such instrument is likely to be subject, I have given it as the *measured* sum, and also to conform to common practice, the sum derived in the usual way has been given as the *read* sum. In case the average means were practically the same, only one has been given, but when both are given, they are distinguished by the same method as that used in distinguishing the sum temperatures.

Larva. Even when first hatched, the larva can crawl rapidly about and, fastening its single proleg, can raise one-half of its body free of support and wave it about. Under moist conditions the just-hatched larva can remain active for as much as two days without food, but if subjected to drying, it will quickly perish. Careful experiments have shown that the just-hatched larva can crawl at least four inches through moist soil under ordinary weather conditions. There is, however, no evidence to show that it crawls in any especially determined direction, except, possibly, downward. It will as readily crawl away from food as toward it, but enters the soil at the first crevice it finds. As the larva grows, the yellow color so characteristic in early stages becomes less and less apparent until, in its later stages, it is white without a trace of yellow. During its entire life, the larva lives in the soil on or in the roots of its food plant, or in the stem. It is perfectly capable of passing from root to root, or even from plant to plant. So long as the larva has moist soil it can live and work for its food, but with the advent of drought it dies. Certainly these experiments and observations abundantly confirm Sirrine's statement that the larva requires moist earth to live in. When it becomes full-grown, it crawls out of and away from the plant from one-fourth of an inch to several inches, and by turning movements of its body, forms an oval earthen cell. The cell is frail, but very smooth and cozy, with no evidence of silk of any sort being used in its construction. This cell may be broken and, unless the larva has begun to shorten and stiffen for pupation, it will crawl away and construct a new one.

By the records of 24 individuals the length of time required to pass from hatching to larval cell was shown to vary from 26 to 38 days, with an average of 28.1. This stage was passed under an average daily mean temperature of 73° F. with sum temperatures of 2068.9° F. (read) or 2063.8° F. (measured).

Pupa. The location of the pupal cell appears to vary with moisture. It is always, so far as our observation goes, constructed in moist soil, although later it may become very wet or very dry. The actual location of the cells varied from one-half to two and one-half inches below the surface.

Records for 10 pupæ show an average of 13.9 days as the length of pupal stage. Records of 14 individuals show that an average of 24 days is required for the insects to pass from larval cell to adult, under an average mean temperature of 66° F. (read) or 65° F. (measured), with a sum temperature of 1590.78° F. (read) and 1576.78° F. (measured).

Seasonal History. The beetles were first observed in 1907, June

1st, on a small elm bush growing in a slough in the midst of heavy conifer timber. They were found in the same situation again two days later. On June 18th they were found on the blossoms and leaves of syringa near the experiment station in such numbers that we counted at least a half-dozen every time we visited the bush. Throughout June 19th and 20th they continued to feed in the same place and in about the same numbers. On June 21st the beetles were discovered in great numbers on volunteer squash near a small woodland, and by June 24th they had appeared in injurious numbers in a squash patch that lay a little farther from the same woodland. At this time they were found copulating freely. On June 25th they appeared in injurious numbers on the trap squash of our cucumber experimental plats. These plats were twice as far from the woodland as the squash fields first infested. By June 26th the beetles had begun to eat the cucumbers, but evidently preferred the squash plants, picking them out even from the midst of cucumber plants. On June 29th they appeared for the first time in the experimental plats of squash. This was fully one-eighth of a mile from any woodland and the late infestation points significantly to the probable winter quarters of the beetles. They continued in the plats from this time forward until August, in the latter part of which the remainder of the old brood practically disappeared. The new brood, particularly the males, began to appear in late August and the majority were out by the middle of September. Practically all had gone into winter quarters by early October. Dissection of material collected at intervals from June until the middle of October showed clearly that the species is single-brooded in New Hampshire.

It has been found that the disturbance necessary to the determination of length of pupal period hastened the development of the insects. It was, of course, necessary to break the earthen cells and, once pupation had occurred, no more cells were constructed. The pupæ exposed were carefully embedded in moist earth and allowed to produce adults. Twenty-two individuals that came through to adults and were thus disturbed at pupation, occupied an average of 47.81 days under an average mean temperature of 70° F. and with an accumulation of 3363.04° F. (read) or 3351.5° F. (measured), while 14 specimens that passed without disturbance from hatching to adult required an average of 55.14 days under an average mean temperature of 69° F., with an accumulation of 3814.96° F. (read) or 3802.35° F. (measured). The specimens that were disturbed by breaking the pupal cell required an average of 56.5 days to pass from deposition of egg to adult beetle, under an average temperature of 70° F. with

an accumulation of 4016.8° F. (read) or 4002.5° F. (measured), while those that were thus undisturbed required an average of 63.8 days under an average mean temperature[2] of 70° F., with an accumulation of 4468.78° F. (read) or 4453.3° F. (measured).

Injury

The insect injures the plants both as an adult and as a larva, but in New Hampshire the adult is much the more serious, for it attacks the plants while they are young and when they are less able to withstand injury. Frequently it will attack the stalk just below the surface of the ground and eat almost, if not quite, through it. Many an injured plant will not be eaten enough to kill it, but the wound will harden and the plant grow, even until it has begun to run, when the first hard wind snaps it off at the point of injury. If the insects are abundant and prompt measures are not taken, the whole crop will be utterly destroyed in a few days. Even when plants have reached a height of three or four inches and have grown strong and stocky, the beetles will sometimes concentrate, especially on replants, and destroy them.

In New Hampshire the larvæ are rarely sufficiently abundant to do serious damage, although plants may be found every year which have been attacked and killed by them. Larvæ have been found among squash roots in the field, but there was little evidence that they had been feeding on the finer roots and only a few instances where they were found feeding on the larger ones. In potted squash where the larvæ were relatively more abundant, they were found feeding within the roots and the stems, even going as high as three or four inches above the ground. Certainly where the larvæ were sufficiently abundant, they would do serious damage.

From the time the plants begin to flower, the beetles desert the foliage and feed on the pollen until driven into winter quarters in the fall.

Natural Enemies

Certainly at least one, if not two, dipterous parasites prey on adult beetles, and doubtless many such predaceous enemies as ground

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[2]The average mean temperature for the whole period was determined in this case by dividing the accumulated temperature by the total number of days required for the transformation, and the accumulated temperatures were determined by adding the average accumulated temperature for egg-state to average accumulated temperature for period extending from hatching to adult. Circumstances rendered the data such that the average mean and accumulated temperatures from egg-deposition to adult could not be computed directly.

beetles and ants feed on the larvæ. Dissections, beginning with beetles collected in June and extending to the time the beetles left the plants, show first a great increase and then a decrease of parasitism, as the following per cents will indicate. Beetles collected during the first two-thirds of June showed 3% containing parasites; those on June 28th, 7%; those on July 30th, 7½%; those on August 5th, 18%; those on August 8th, 42½%; those on August 13th, 50%; those on August 14th, 50%; those on August 22d, 24%; those on August 31st, 12%; those on September 7th, 0%; those on September 12th, 0%; those on September 18th, 0%.

Some idea of the mortality that may well occur in nature may be gathered from the fact that in soil regularly watered and kept constantly producing young plants, out of 329 larvæ introduced into the soil at hatching, only 34 reached maturity.

Methods of Combating

In the study of artificial methods we experimented with several substances as preventatives, as the solution of this problem appears to lie in prevention rather than in cure. One-half of an acre of cucumber plants and two and one-half acres of squash were used in the experiment. These were divided into plats and treated with Bordeaux (3 pounds Copper Sulphate, 4 pounds lime, to 50 gallons of water), Bordeaux plus Paris green, air-slaked lime plus sulphur, sulphur, "Bug Death," Hammond's "Slug-Shot," tobacco dust, road dust, arsenate of lead (3 pounds to 50 gallons), and arsenate of lead (6 pounds to 50 gallons). The Bordeaux plats were further protected by plantings of squash as trap crops, according to Sirrine's suggestion.

The beetles were serious enough to destroy only about one-fourth of the plants in the check plats, but the effect of their work was well shown in the setback these plats experienced. Bordeaux mixture alone or with Paris green, sulphur, and "Slug-Shot" appeared to stunt the plants. Road dust afforded but little protection, "Bug Death" and tobacco dust when used carefully enough seemed to be fairly efficient, but the air-slaked lime and sulphur mixture seemed just as successful and was certainly much cheaper. Arsenate of lead, however, gave the most efficient protection and injured the plants least of any mixture used. Three pounds seemed almost as successful as six pounds. Our experiments would lead us to advise the following treatment where fungus enemies are a serious problem: Plant trap squash for either cucumber or squash between the hills of every other row, or if the piece be small, about the edge a week or ten days before

the regular crop is set out; plant other trap seed when the regular crop is put in; plant still other trap seed a week or ten days later; keep the regular crop sprayed with arsenate of lead (3 pounds to 50 gallons) until the plants begin to run, then keep sprayed with Bordeaux mixture (3 pounds Copper Sulphate, 4 pounds of lime, 50 gallons of water).

From the very nature of these materials, it is evident that in a bad beetle year, they would be insufficient to protect the plants. In such cases, the only efficient method of protection is by means of covers. Many forms have been invented, all either costly to purchase or to apply, and some both. But the market gardener, who can secure high prices for his prime cucumbers, can afford to use them, so I will take a few minutes of your time in suggesting what has seemed to us a practical sort of cover. Secure yard-wide screen wire of slightly smaller mesh than the ordinary window screening, and cut off one yard. The piece will then be one yard each way. Describe a circle on this piece, having a diameter of 36 inches, and cut off the corners. Then divide this circular piece of wire into two equal parts. Join the cut edges by drawing them together and folding them over, hammering them down firmly. Thus a cone-shaped wire cover costing a few cents and capable of withstanding several years' usage is ready for use. Two covers can be made from each square yard of wire.

Mr. J. B. Smith suggested that the wire used for screens to protect the plants must have a very small mesh.

Mr. R. L. Webster asked concerning the parasites bred from *Diabrotica,* and in reply Mr. Headlee stated that they were Tachinids.

Mr. Burgess inquired concerning the length of time that the adults deposited eggs. He had been able to secure eggs for two successive seasons from a female of *Calosoma frigidum* that had been kept in captivity. To this Mr. Headlee replied that as far as he had observed, the females of *Diabrotica vittata* deposited all their eggs in one season.

A. F. Burgess, *Secretary*

UNIFORM COMMON NAMES FOR INSECTS

By A. F. Burgess, *Washington, D. C.*

At the sixteenth annual meeting of the Association of Economic Entomologists held at St. Louis, Mo., in December, 1903, a Committee on Nomenclature was elected to secure the adoption of uniform names for our more common insects. In the past much confusion has re-

sulted from the use of the same name for a number of entirely different insects, and the work was undertaken in the hope of gradually overcoming the difficulty.

Since that meeting the committee has prepared lists which have been submitted to the leading entomologists of the country for their consideration and approval. All names which were unanimously approved were presented at the next annual meeting of the Association, and those that received unanimous support by that body were ordered printed in the annual report, with the recommendation that they be used exclusively in all publications.

In order to accomplish the object for which this work was undertaken, it is necessary for all entomologists, publishers, editors and writers to use the approved names, and all are urged to do so.

The committee, at the present time, is Prof. Herbert Osborn, Chairman, Columbus, Ohio; Prof. E. G. Titus, Logan, Utah, and Prof. A. L. Quaintance, Washington, D. C. Communications concerning the adoption of names not already listed or suggestions should be sent to the Chairman of this committee.

The following, prepared on the recommendation of the committee, is a complete list of the names which have been accepted during the past four years:

LIST OF NAMES RECOMMENDED FOR EXCLUSIVE USE

American cockroach	*Periplaneta americana* L.
American dagger moth	*Apatela americana* Harr.
Angoumois grain-moth	*Sitotroga cerealella* Ol.
Apple-aphis	*Aphis pomi* L.
Apple curculio	*Anthonomus quadrigibbus* Say.
Apple-leaf skeletonizer	*Canarsia hammondi* Riley.
Apple maggot	*Rhagoletis pomonella* Walsh.
Apple twig-borer	*Schistoceros hamatus* Feb.[a]
Army-worm	*Heliophila unipuncta* Haw.
Ash-gray blister-beetle	*Macrobasis unicolor* Kby.
Asiatic ladybird	*Chilocorus similis* Rossi.
Asparagus beetle	*Crioceris asparagi* L.
Bag-worm	*Thyridopteryx ephemeraeformis* Haw.
Bean-weevil	*Bruchus obtectus* Say.
Bedbug	*Cimex lectularius* L.
Black blister-beetle	*Epicauta pennsylvanica* DeG.
Black cutworm	*Agrotis ypsilon* Rott.
Black scale	*Saissetia oleae* Bern.
Blood-sucking cone-nose	*Conorhinus sanguisuga* Lec.
Boll-weevil	*Anthonomus grandis* Boh.

a. Synonym, *Amphicerus bicaudatus* Say. (See Lesne, P. Revision des Bostrychides. Ann. Soc. Ent. France, 67: 513, 514, 1898.)

Boll-worm	*Heliothis obsoleta* Fab.
Book-louse	*Troctes divinatoria* Mull.
Bronzed cutworm	*Nephelodes minians* Guen.
Brown-tail moth	*Euproctis chrysorrhœa* L.
Buck moth	*Hemileuca maia* Dru.
Bud-moth	*Tmetocera ocellana* Schiff.
Buffalo tree-hopper	*Ceresa bubalus* Fab.
Cabbage aphis	*Aphis brassicae* L.
Cabbage looper	*Autographa brassicae* Riley.
Cabbage-maggot	*Pegomya brassicae* Bouche.
Cadelle	*Tenebrioides mauritanicus* L.
Carpet-beetle	*Anthrenus scrophulariae* L.
Carpet-moth	*Trichophaga tapetzella* L.
Catalpa sphinx	*Ceratomia catalpae* Boisd.
Cattle-tick	*Boophilus annulatus* Say.
Cecropia-moth	*Samia cecropia* L.
Chaff scale	*Parlatoria pergandei* Comst.
Cheese skipper	*Piophila casei* L.
Cherry scale	*Aspidiotus forbesi* Johns.
Chestnut weevil	*Balaninus rectus* Say.
Chinch-bug	*Blissus leucopterus* Say.
Cigarette beetle	*Lasioderma serricorne* Fab.
Clover cutworm	*Mamestra trifolii* Rott.
Clover-hay worm	*Hypsopygia costalis* Fab.
Clover mite	*Bryobia pratensis* Garm.
Clover-root borer	*Hylastinus obscurus* Marsham.
Clover-stem borer	*Languria mozardi* Latr.
Codling-moth	*Carpocapsa pomonella* L.
Colorado potato-beetle	*Leptinotarsa decemlineata* Say.
Corn root aphis	*Aphis maidi-radicis* Forbes.
Cotton-stainer	*Dysdercus suturellus* H. Schf.
Cottony cushion-scale	*Icerya purchasi* Mask.
Cottony maple-scale	*Pulvinaria innumerabilis* Rathv.
Currant borer	*Aegeria tipuliformis* Clerck.
Dingy cutworm	*Feltia subgothica* Haw.
Elm-borer	*Saperda tridentata* Ol.
Fall armyworm	*Laphygma frugiperda* S. & A.
Fall canker-worm	*Alsophila pometaria* Harr.
Fall web-worm	*Hyphantria cunea* Dru.
Forest tent-caterpillar	*Malacosoma disstria* Hbn.
Garden webworm	*Loxostege similalis* Guen.
Glassy cutworm	*Hadena devastatrix* Brace.
Granary-weevil	*Calandra granaria* L.
Grape leaf-folder	*Desmia funeralis* Hbn.
Grape flea-beetle	*Haltica chalybea* Ill.
Grape-phylloxera	*Phylloxera vastatrix* Planch.
Gray blister-beetle	*Epicauta cinerea* Forst.
Gypsy-moth	*Porthetria dispar* L.
Harlequin cabbage-bug	*Murgantia histrionica* Hahn.
Hessian-fly	*Mayetiola destructor* Say.
Hickory borer	*Cyllene picta* Dru.

Honey-bee	*Apis mellifera* L.
Hop-aphis	*Phorodon humuli* Schrank.
Horn-fly	*Haematobia serrata* R.-D.
Horse bot-fly	*Gastrophilus equi* L.
House cricket	*Gryllus domesticus* L.
House-fly	*Musca domestica* L.
Imbricated snout beetle	*Epicaerus imbricatus* Say.
Indian-meal moth	*Plodia interpunctella* Hbn.
Lappet moth	*Epicnaptera americana* Harr.
Larder-beetle	*Dermestes lardarius* L.
Leaf crumpler	*Mineola indiginella* Zell.
Leopard-moth	*Zeuzera pyrina* L.
Margined blister-beetle	*Epicauta marginata* Fab.
Mediterranean flour moth	*Ephestia kuehniella* Zell.
Melon caterpillar	*Diaphania hyalinata* L.
New York weevil	*Ithycerus noveboracensis* Forst.
Northern mole cricket	*Gryllotalpa borealis* Burm.
Onion maggot	*Phorbia cepetorum* Meade.[b]
Onion thrips	*Thrips tabaci* Lind.
Orange scale	*Aonidiella aurantii* Mask.
Oyster-shell scale	*Lepidosaphes ulmi* L.
Pale-striped flea-beetle	*Systena blanda* Melsh.
Palmer-worm	*Ypsolophus ligulellus* Hbn.
Peach-borer	*Sanninoidea exitiosa* Say.
Peach-scale	*Eulecanium persicae* Fab.
Pear psylla	*Psylla pyri* L.
Pear-slug	*Eriocampoides limacina* Retz.
Pea-weevil	*Bruchus pisorum* L.
Pickle worm	*Diaphania nitidalis* Cram.
Pigeon-tremex	*Tremex columba* L.
Pistol case-bearer	*Coleophora malivorella* Riley.
Plum-curculio	*Conotrachelus nenuphar* Hbst.
Plum-gouger	*Anthonomus scutellaris* Lec.
Potato stalk-borer	*Trichobaris trinotata* Say.
Putnam's scale	*Aspidiotus ancylus* Putn.
Raspberry sawfly	*Monophadnoides rubi* Harr.
Red-legged locust	*Melanoplus femur-rubrum* DeG.
Rice-weevil	*Calandra oryza* L.
Rose-chafer	*Macrodactylus subspinosus* Fab.
Rose sawfly	*Endelomyia rosae* Harr.[c]
Rose scale	*Aulacaspis rosae* Bouché.
Saddle-back caterpillar	*Sibine stimulea* Clem.
Salt-marsh caterpillar	*Estigmene acraea* Dru.
San José scale	*Aspidiotus perniciosus* Comst.
Screw-worm	*Chrysomyia macellaria* Fab.

b. This species is placed by Coquillett in the genus Pegomya Desvoidy. (See Chittenden, Cir. 63, 2d. ed. Bur. Ent., U. S. Dept. Agr., p. 6, footnote 2, 1906.)

c. For reference of this species to the genus Endelomyia see Ashmead. (Can. Ent., 30: 256. October, 1898.)

Scurfy scale	*Chionaspis furfura* Fitch.
Sheep tick	*Melophagus ovinus* L.
Silkworm	*Bombyx mori* L.
Spring canker-worm	*Paleacrita vernata* Peck.
Squash borer	*Melittia satyriniformis* Hbn.
Squash-bug	*Anasa tristis* DeG.
Stable fly	*Stomoxys calcitrans* L.
Stalk borer	*Papaipema nitela* Guen.
Strawberry crown-borer	*Tyloderma fragariae* Riley.
Strawberry leaf-roller	*Ancylis comptana* Fröhl.
Strawberry weevil	*Anthonomus signatus* Say.
Striped blister-beetle	*Epicauta vittata* Fab.
Tarnished plant-bug	*Lygus pratensis* L.
Tomato-worm	*Phlegethontius sexta* Joh.
Turkey gnat	*Simulium meridionale* Riley.
Variegated cutworm	*Peridroma saucia* Hbn.
Vagabond crambus	*Crambus vulgivagellus* Clem.
Walking-stick	*Diapheromera femorata* Say.
Walnut case-bearer	*Mineola juglandis* LeB.
Walnut-sphinx	*Cressonia juglandis* S. & A.
Wheat-head army-worm	*Heliophila albilinea* Hbn.
Wheat midge	*Contarinia tritici* Kby.
White-lined sphinx	*Deilephila lineata* Fab.
Yellow mealworm	*Tenebrio molitor* L.
Yucca-moth	*Pronuba yuccasella* Riley.
Zebra-caterpillar	*Mamestra picta* Harr.

TICK-BORNE DISEASES AND THEIR ORIGIN

By Nathan Banks, *Washington, D. C.*

Texas or splenetic fever was first described as a disease of cattle in this country by Dr. J. Pease about 1795 from an outbreak at Lancaster. He concluded that it was due to an importation of cattle from North Carolina. Gradually it was discovered that when southern cattle were brought north in summer, northern cattle along the route would sicken and die, while northern cattle taken south also contracted the disease, although the southern cattle generally remained in good health.

It had long been known to cattle-raisers in the southern states that cattle dying from Texas or Spanish fever were infested with ticks, and it was therefore quite natural for them to attribute the disease to the tick. Veterinarians, however, did not believe it, and Gamgee, in his extensive report on the diseases of cattle (1869), argued against the supposed connection. In 1890 Dr. P. Paquin considered the tick as one agent in transmission, but he had little actual evidence. In 1889 Dr. F. L. Kilborne of the Bureau of Animal Industry, thought

to test the popular theory and became convinced that the presence of the cattle-tick was necessary to the transmission of disease. Later, he, with Dr. T. Smith, proved that the tick was an intermediary host of the blood parasite causing the disease and in the same year Dr. Theobald Smith described the parasite as *Pyrosoma bigeminum*, now *Piroplasma*. The southern cattle accustomed to tick infestation from birth, become immune to the disease, but if not raised in tick-infested fields they are as susceptible to the disease as northern cattle.

Since 1890 many experiments by various observers have served to confirm Dr. Kilborne's results. Diseases similar to Texas fever occur in cattle in various parts of the world. In South Africa Lounsbury has shown that heartwater is transmitted by the "bont tick," *Amblyomma hebræum*. Later he has shown that malignant jaundice in dogs is due to the attack of a dog tick, *Haemaphysalis leachi*, and that African coast fever in cattle is carried by five species of *Rhipicephalus*. In each case there are differences in the manner of infection and the stage of the tick capable of infecting an animal, and various peculiarities in the life history of each tick.

These discoveries have served to open a wide field of suspicion and investigation, so that during the past few years ticks have been accused of transmitting many different diseases to various animals. The evidence, however, in many cases, is far from conclusive, but, doubtless, as experiments are carried on proof will become established of the culpability of other ticks in the diffusion of disease.

Louping ill in sheep is thought to be carried by an *Ixodes*; spirillosis in fowls is attributed to an *Argas*; spotted fever due to the presence of a *Dermacentor*. A disease of turtles is laid up to *Hyalomma ægyptium*; carceag, an European disease of sheep, is supposedly transmitted by *Rhipicephalus bursa*. An undetermined Ceylonese tick is credited with producing paranghi or "yaws." Infected specimens of *Ixodes ricinus* have given a piroplasmosis to European cattle; and the "moubata bug" (*Ornithodoros moubata*) is the inoculating agent of one of the most dangerous diseases dreaded by inhabitants of West Africa.

From the known results, it is evident that the power to transmit disease is not confined to any one genus or section of *Ixodidæ*, but common to all. Moreover, in different countries extremely similar diseases are carried by very different ticks. Therefore the diseases have not originated in the ticks. Most, if not all, of the species now acting as agents in the dissemination of disease to certain hosts were probably originally confined to other hosts. To their original or natural host they brought no disease. Certain low organisms living in

the blood of the host were transmitted by the ticks to other animals of the same nature without serious danger. But when a tick containing the blood parasites of one, its natural, host becomes attached to a new and different kind of host, then the blood-parasite in this alien blood may originate a disease. The occasional transference of a tick from one host to another may not be sufficient, but when a species of tick practically changes its host, then a disease may result, provided, of course, that the ticks are commonly infected with a blood parasite of their old host.

This theory of the origin of these diseases, though new to me, I find has been proposed by Dr. H. M. Woodcock in a paper on the Hæmoflagellates.* Doctor Woodcock was mostly concerned in the diseases transmitted by flies, but as he includes in his general review a reference to piroplasmosis, it is evident that he considers the tick-borne diseases as originating in the same way as the others. Doctor Woodcock's statement follows: "It follows, however, from what has been said above, that the animals for which these parasites are markedly pathogenic cannot be regarded as their true or natural hosts, which are rather to be sought among the native, tolerant animals of the locality concerned."

In accordance with this theory then, the ticks in adapting themselves to the march of civilization, the extermination of native animals and the introduction of domestic animals, have here and there transmitted to domestic animals blood-parasites that are normally found in certain wild species.

The tick is a most necessary part in the life-history of these parasites, for in some cases (perhaps all) the sexual conjugation of the parasite is consummated within the body of the tick.

It is therefore evident that all ticks are potentially dangerous. Any tick now commonly infesting some wild animal, may, as its natural host becomes more uncommon, attach itself to some domestic animal. Since most of the hosts of ticks have some blood-parasites, the ticks by changing the host may transplant the blood-parasite into the new host, producing, under suitable conditions, some disease. Numerous investigators throughout the world are studying this phase of tick-life, and many discoveries will doubtless signalize the coming years.

* Quart. Journ. Micr. Sci. (N. S.) vol. 50, p. 158, 1906.

NOTES ON TROGODERMA TARSALE MELSH.

By C. O. Houghton, *Newark, Delaware.*

In the fall of 1906 I found that a few shag-bark hickory nuts (*Hicoria ovata* Mill.) which I had in my laboratory were more or less infested with Dermestid larvæ. Wishing to determine the species responsible for the injury, I placed a nut that I had cracked and found infested in a shell vial, which I tightly corked and set upon my office desk, where I could frequently inspect it. I occasionally saw larvæ moving about in the vial and some time later observed one or more adults of *T. tarsale*, which finally died therein and were evidently eaten by the larvæ.

Having determined the species and made a note of the injury and identification of the insect responsible for it, I set the vial, which I had not opened, aside and thought no more about it for several months. On December 24, 1907, I noticed the vial again, and upon making an examination of its contents was somewhat surprised to find that it still contained living larvæ.

The shell of the nut had been broken into three or four pieces, and I had supposed that the meat had been wholly removed from these long before; at least it had appeared so from the previous examinations I had made. Nevertheless, I removed therefrom no less than fifty-eight living larvæ of various sizes, and all, apparently, in the best of condition. They were all within the pieces of shell and were unquestionably feeding upon the inside of the shell itself, for this was considerably eaten in places and not a trace of the meat of the nut could be found. In the bottom of the vial there was a considerable amount of dust and excrement, and I counted about fifty good-sized cast larval skins, more or less perfect, therein. In addition, there were numerous small pieces of skins, apparently the remains of some that had been fed upon to some extent by the larvæ. No trace of any adults was to be found, however.

The pieces of shell and the larvæ were again placed in the vial, and this was not examined again until January 18, 1908, when I found fifty-six living larvæ therein.

Early in February I noticed that one or more of the larvæ were entering the cork in the vial at a slight crack on the lower side, and a short time later (February 19) I found four good-sized larvæ snugly ensconced therein, all lying close together. They had eaten, or at least hollowed out, quite an opening at this point and I thought that possibly they were preparing to pupate therein.

An examination of the pieces of shell in the vial at that time resulted in my finding fifty-six living larvæ. Some of these were quite small, measuring but 2.5 mm. in length (exclusive of the terminal brush), and had possibly been overlooked in some of my previous examinations. The largest larva measured 6 mm. in length, exclusive of the brush. About fifteen cast skins were found at this time.

On March 30th I noticed the first adult of this brood in the vial, and upon making an examination of the pieces of shell I found fifty-four living larvæ, one of which was about to pupate. In addition, there were four living larvæ in the cork and about thirty-five cast skins mixed with the excrement and dust at the bottom of the vial.

In time I expect that all, or practically all, of these fifty-seven larvæ will reach maturity and pupate, with nothing but their present food supply to subsist upon; for it is very evident that they can maintain themselves on these rations.

T. tarsale in the larval state, has been recorded* as feeding upon a variety of substances, among which may be mentioned the following: Flaxseed, castor beans, Cayenne pepper, peanut meal, wheat, etc., but as far as I am aware it has never been reported as being able to subsist and reach maturity upon such scant rations as dry hickory nutshells.

FILLING THE CALYX CUP

A. L. Melander, *Pullman, Wash.*

A year ago Dr. E. D. Ball presented before the nineteenth meeting of the Association of Economic Entomologists a most valuable paper on spraying for the codling moth (Bull. 67 U. S. Bureau of Entomology). His work had led him to believe that spraying for the first brood could be so effectively done as to render later sprayings unnecessary.

The keynote of this treatment is that as the majority of larvæ, both early and late, enter the calyx cup, that part of the apple needs poison more than any other part of the tree. To place poison below the stamens requires a high pressure of 100 to 200 pounds, a coarse driving spray, and the spray must be rained down on the flowers until the tree is drenched. Arsenate of lead must be used, but it need not be stronger than one pound to fifty gallons. A mist spray will not penetrate into the lower cup, nor will a coarse spray shot directly into the tree to fall by gravity into the upturned flowers. When the lower calyx cup is full there is enough spray on the foliage and fruit

*Chittenden, Bull. No. 8, U. S. Dept. Agric., Div. of Ent., p. 19.

to poison practically all first brood larvæ that fail to reach the lower cavity. There can then be no late larvæ, and consequently apples escape late blemishing stings, as well as the chance of becoming wormy through late ineffective sprayings.

Although this method of treatment has proved not only practicable but better than any other method in the Pacific Northwest, in many districts of Colorado, Utah, Idaho, Washington, and California, there are many Eastern entomologists who firmly believe that it is inapplicable to the conditions east of the Rocky Mountains.

In the discussion of Dr. Ball's paper, as recorded in Bulletin 67 of the Bureau of Entomology, "Mr. Fletcher pointed out the desirability of not casting any doubt on the efficiency of methods now generally in vogue for controlling this insect. In Canada 70% of the apple crop is saved by the present acknowledgedly imperfect spraying methods. He did not believe it necessary to lay so much stress on filling the calyx, and was decidedly in favor of delivering the spray in as mistlike condition as possible. Excellent paying results were now being secured by ordinary farmers with the mist spray which has been used for several years." The contention is that if we can save 70% there is no use in trying for 100%.

"Mr. Quaintance pointed out that fruit-growing conditions in the Mississippi Valley and Eastern States were quite different from many sections of the West, such as Utah. The absence of rains there during the growing season largely obviated the necessity of fungicides. While he did not doubt that it was entirely practicable to use a coarse spray for the codling moth in Utah and thoroughly drench the trees, this would be a bad practice according to present ideas of spraying in the East, where a mist-like spray is desired to treat uniformly all parts of the foliage and fruit. Under present conditions of spraying, young apples are often russeted by the Bordeaux and arsenical treatment, especially by the one just after the petals have fallen, and a thorough drenching of the trees at this time would be likely to prove harmful in this way." Of course, it is harmful and expensive to drench the trees with Bordeaux mixture, and the conservative fruit grower feels that to apply the two mixtures separately is more trouble than the fruit crop is worth.

The editor of the Fruit Grower of St. Joseph, Missouri, in commenting on our methods of spraying in the January issue of that paper, thought it necessary to add that "Professor Melander's experiments were conducted in an irrigated country and therefore rains did not wash any of the poison from the foliage nor from the young fruit." It should be unnecessary to remind him and many others

that it rains in Washington as well as elsewhere. In fact, after the second spraying one year in the Yakima Valley three inches of rain fell in a few hours, yet where arsenate of lead was used there was no need of re-applying the spray. Last year we gave the first spraying of one orchard at Walla Walla in a hard wind and rain, yet with the same perfect results as elsewhere, for our spray at 200 pounds pressure penetrated below the stamens, while the rain did not.

Since 1901 the Illinois Experiment Station has been comparing high and low pressures and misty and coarse sprays in treating the codling moth. They conclude that "the application which was most effective in filling the calyx cavity was that made in the form of a fine mist by means of a Vermorel nozzle under high pressure." (Ill. Bull. 114, p. 383, 1907.) That may be true when it applies only to the *outer* calyx cavity, where the larvæ do not enter the apple. The fourth year of this experiment a pressure guage was secured for the pump, when it was discovered that the "high pressure was probably about eighty pounds."

Even so recent and authoritative a paper as Farmers' Bulletin 247 (1906), obviously written from office experience rather than acquaintance with field conditions, ignores arsenate of lead, advises a fine mist spray always, and suggests six sprayings for the codling moth. And yet when a Western Experiment Station asked for an Adam's fund project on the codling moth we are assured by the Office of Experiment Stations that the Bureau of Entomology advises "that the codling moth problem is solved."

Dr. Ball's paper evidently aroused interest at the New York meeting, for we now find in the second number of the new Journal of Economic Entomology a summary of an extended statistical experiment on the value of early sprayings in New Hampshire. This project was undertaken by Director E. D. Sanderson, and was an attempt to apply Western methods to Eastern conditions.

"Plot 1 was given the spraying immediately after the petals fell, with a fine mist. Plot 2 was sprayed at the same time with a Bordeaux nozzle and thoroughly drenched, the spray being applied at 100 pounds pressure. Neither of the plots were sprayed subsequently. This experiment was repeated under similar conditions in another orchard. There was but 2% or 3% difference in the results in both cases, in one orchard favoring the drenching and in the other favoring the mist, so that we are forced to the conclusion that there is very little difference in their effectiveness." . . . "Considering the total benefits for the season, it was found that spraying the calyx only may give a benefit of 62%," which is surprisingly low compared with Western results. The explanation, however, is clear

when we read that "careful examination of the calices by Dr. Headlee failed to show any spray lodged beneath the stamens or in the calyx cavity proper." An attempt was made to apply Western methods to Eastern conditions, that is to fill the lower calyx cup with poison as the best treatment for the codling moth, but the most essential point was neglected,—the spray was not shot *down* and was not put in the only place where it was needed.

All of which reminds me of the early troubles in the East over the sulphur-lime wash; how the impractical spraying of a couple of entomologists induced a neglect of a tried remedy, known to be completely effective on the Pacific coast, with a consequent ruin of millions of dollars of orchard property. Since, "in a second bulletin from the U. S. Department of Agriculture, the chemical reactions of the wash were set forth and it was shown almost conclusively that sulphur-lime could not reasonably be expected to be of much value in the moist East" (Bull. 37, p. 55, U. S. Bureau of Entomology). This neglect might have continued until today had not Dr. Forbes' experiment of washing off the spray with a pump and yet finding the scale dead, or the successes of a few practical fruit growers awakened official entomologists to the fact that something was wrong. This neglect of the sulphur-lime wash in the East has had an important economic bearing, since probably as much as any one factor it has been responsible for the transfer of interest in fruit growing from the East to the West.

Now, the purpose of this paper is not to antagonize Eastern entomologists, but to call attention to the fact that a most important field is still open for investigation. The success of careful filling of the calyx cup has been too universal in the far West to believe it is inapplicable elsewhere. If some Eastern entomologist will actually spray as we do in this region and give our methods the trial they deserve, the sole purpose of this article will have been accomplished. But an apathy to successful methods if continued will be detrimental to the profession of economic entomology, especially when the insects concerned are as prominent as the San José scale and the codling moth.

REPORT OF THE SIXTH ANNUAL MEETING OF THE AMERICAN ASSOCIATION OF HORTICULTURAL INSPECTORS

The sixth annual meeting of this association was held at the Windsor-Clifton Hotel, Chicago, Ill., December 27, 1907. Mr. A. F. Burgess, Washington, D. C., presided and Prof. James Troop, La-

fayette, Ind., secretary of the association, was also present. The following twenty-one states were represented by the official inspectors or deputy inspectors: Connecticut, Dr. W. E. Britton; Georgia, Mr. E. L. Worsham; Idaho, Mr. J. R. Field; Illinois, Dr. S. A. Forbes and Mr. J. A. West; Iowa, Prof. H. E. Summers; Kansas, Dr. T. J. Headlee; Louisiana, Prof. Wilmon Newell; Massachusetts, Dr. H. T. Fernald; Maryland, Prof. T. B. Symons; Michigan, Prof. L. R. Taft; Minnesota, Prof. F. L. Washburn; Nebraska, Prof. Lawrence Bruner; New Hampshire, Prof. E. D. Sanderson; New Jersey, Dr. J. B. Smith; New York, Mr. P. L. Heusted; North Carolina, Prof. Franklin Sherman, Jr.; Oklahoma, Prof. John F. Nicholson; Pennsylvania, Mr. E. B. Engle; Tennessee, Prof. H. A. Morgan and Prof. G. M. Bentley; Virginia, Prof. J. L. Phillips; West Virginia, Prof. W. E. Rumsey and Prof. Fred E. Brooks. Official entomologists not directly connected with horticultural inspection work were also present from Alabama, Delaware, Indiana, Maine, Missouri, Ohio and the District of Columbia. The American Association of Nurserymen was represented by its President, Mr. J. L. Hill of Des Moines, Iowa, Prof. John Craig, Ithaca, N. Y., Mr. Orlando Harrison, Berlin, Maryland, and Col. C. L. Watrous, Des Moines, Iowa.

A report was presented by Mr. Orlando Harrison, chairman of the joint committee on national law for the control of introduced insect pests, as follows:

"*To the Members of the American Association of Horticultural Inspectors.*

"GENTLEMEN: As chairman of the committee on uniform inspection of nursery stock for the American Association of Nurserymen appointed by our president at our last annual meeting, it is a pleasure to say that I sent out about 88 letters to various nurserymen and have received 60 replies, sufficient to indicate that they are desirous of some action being taken along the line of uniform inspection, and from the information gathered, it is safe to say that the majority of nurserymen welcome inspection by the entomologists or by competent assistants, and also by pathologists, and a better understanding is desired on the part of the nurserymen of what is expected of them.

"It was clearly shown in the correspondence which I received that the majority of our nurserymen desire a change in conflicting laws of the various states. They want one inspection, and one certificate which will permit them to ship into the various states.

"It is also clearly shown by their correspondence that something

must be done for their relief, as the excessive amount of red tape is expensive under present conditions.

"I am here to tell you that the nurserymen are anxious to coöperate with you in combating, controlling and stamping out, if possible, the insect pests and diseases that are liable to be found in the nursery. We realize that it is our duty to our customers, and to you horticultural inspectors, as our representatives who issue the certificates, that you be placed in the proper light with each other and with the grower in issuing these certificates from one state to another; but it does seem to us that more attention should be paid by the inspectors to neglected orchards near a nursery, and the various shade, ornamental and fruit trees commonly found in a city or small town near a nursery, and in making your demand on the nurseryman, a similar demand should be made upon the owners of such property. The nursery business is now already overtaxed and we desire coöperation with inspectors in causing such places to be treated or destroyed. We pray you not to overlook the other fellow, just across the fence, who is more dangerous to us than the man who would set fire to our buildings.

"I heartily join in the sentiments expressed by our President, Mr. Hill, this afternoon at the meeting of the entomologists, and my only desire is that you will all actively coöperate in bringing about the desired legislation.

"I would be pleased to see this association endorse the resolutions as presented to the Association of Economic Entomologists this afternoon. I thank you for the opportunity of presenting this matter before you, and hope for your earnest consideration of the same."

This committee also presented, through Dr. S. A. Forbes of Urbana, Ill., the following resolutions, which were the same as those endorsed by the Association of Economic Entomologists, and they were unanimously adopted:

A.—*Resolved*, That the Secretary of Agriculture should be empowered to make regulations governing importations liable to harbor insect pests or plant diseases; to require such importations to be accompanied by the certificate of a duly accredited entomologist of the country in which said shipments originate; or in the absence of such certificate, to make inspection of such shipments, by competent agents, at point of destination and that sufficient appropriation be made for this purpose by Congress.

B.—(1). That Congress be asked to enact a law empowering the Secretary of Agriculture to issue certificates of nursery inspection, as nearly uniform as possible, to all nurseries in the United States engaging in interstate trade, upon proper inspection of such nurseries by duly authorized representatives of the U. S. Dept. of Agriculture or by state officials approved by the Secretary of Agriculture for that purpose, and that sufficient appropriation be made therefor.

(2) That all state or territorial officials in charge of nursery inspection be urged to accept the certificates at their face value, and that in states where laws are now in force which will not allow the acceptance of such certificates, the inspection departments be requested to endeavor to secure such state legislation as will make this possible.

C.—That Congress should authorize the Secretary of Agriculture to proceed to exterminate or control imported insects or plant diseases, or any insect previously native to a restricted locality, but which may become migratory and threaten the whole country, whenever in his judgment such action is practicable, and that an appropriation be made for this purpose as a reserve fund for emergency use against any such pest which may arise.

D.—The joint committee proposes to have two bills prepared for introduction in Congress, one of these embracing the subject matter of sections A and B above, and the other embracing only the subject matter of Section C, and that if the passage of both measures be found impracticable or impossible, then all efforts be concentrated in the attempt to secure passage of the bill involving the certification and inspection of imports and the control of nursery stock shipments entering into interstate trade, as above outlined.

As the authors of papers to be presented at this meeting were absent, the questions for general discussion were considered as follows:

1. Is the method of dipping nursery stock in a contact insecticide as satisfactory as fumigation?

The discussion of this question brought out the fact that in the Northwestern states the dipping of nursery stock for destroying San José scale is considered an efficient remedy. No extensive experiments along this line were reported, showing that this method was more effective than fumigation. After general discussion the concensus of opinion was that fumigation was preferable, and that no harm would result to the trees if the work was properly done.

2. What further precautions, if any, than those employed now can be adopted to prevent the dissemination or injury caused by crown-gall?

This question was thoroughly discussed, but no better plan was proposed than the one now in general use, namely, the destruction of infested trees and plants.

3. What privileges shall be allowed in the purchase and sale of nursery stock known to be scaly by both purchaser and seller?

This question brought out a general discussion and exchange of views from many of the inspectors and entomologists present. The attitude taken on this matter seemed to depend largely on the local conditions. No definite action was taken by the association, but the prevailing sentiment indicated that it was unwise to allow the shipment of stock known to be infested.

The following officers were elected for the ensuing year: President, Prof. H. E. Summers, Ames, Iowa; Vice-President, Prof. F. L.

Washburn, St. Anthony Park, Minnesota; Secretary, Prof. T. B. Symons, College Park, Maryland.

The association then adjourned to meet in joint session with the Association of Economic Entomologists at 10 o'clock the following morning, when papers and discussions of special interest to both associations were presented. The report of the joint session is included in the annual report of the Association of Economic Entomologists.

JAMES TROOP, *Secretary.*

NATIONAL INSECTICIDE BILL

As intimated in the last number of the JOURNAL, measures looking toward the national control of insecticides and fungicides have been introduced into Congress; Senate Bill 6515 by Senator A. B. Kittredge of North Dakota, and House Bill 21318 by Hon. Frank A. Lowden of Illinois, which bills are practically identical. The Senate bill was referred to the Committee on Agriculture and Forestry, of which Senator H. C. Hansbrough is chairman, and the House bill has been referred to the Committee on Interstate Commerce, of which Hon. William P. Hepburn is chairman. Copies of the Senate bill have been sent to all leading members of the Association of Economic Entomologists, Experiment Station directors, official chemists, manufacturers and others interested in such legislation. From an extensive correspondence, it is very evident that there is a widespread sentiment among the leading manufacturers in favor of such legislation. Several minor amendments to the bills introduced are undoubtedly desirable.

It now seems probable that a conference between the manufacturers, chemists and entomologists will be held in the near future, at which time desirable amendments will be agreed upon. The chairman of your committee begs to request that the entomologists carefully scrutinize this measure and send him any definite suggestions as to desirable amendments. There seems no probability of the measure passing at this session of Congress, but it will undoubtedly be re-introduced next December, and it is urged that it be called to the attention of state and local fruit and truck growers' organizations, and others who would be interested in its passage, and that they be urged to follow the course of this legislation and aid it as much as possible. It seems that its passage will depend very largely upon how much public sentiment is shown in its favor, as we believe that there will not be any serious organized opposition.

E. DWIGHT SANDERSON,
Chairman, Committee on Proprietary Insecticides.

OBSERVATIONS ON THE GENUS CONTARINIA

By E. P. Felt, *Albany, N. Y.*

This genus is of economic importance, despite the fact that the insect Americans have hitherto known as *Diplosis* or *Contarinia tritici* Kirby can not be referred thereto. In passing, we wish to state that there is some question as to the identity of *Diplosis tritici,* and the writer would appreciate most thoroughly any assistance other entomologists could give in the way of securing additional material this season. Similarly, *Diplosis violicola* Coq., though a species of much importance to violet growers, can not be retained in this genus.

One of the best known members of the genus is *C. pyrivora* Riley, an insect which was brought into this country about 1877 and which has caused a large amount of injury to pear growers, particularly in Connecticut, New York and New Jersey. This importation is a very well marked form, differing so widely from American species that one antennal segment of the male is sufficient for its recognition. Careful comparisons between American-bred insects and others received from Europe have established the identity of the two beyond question. There is but one generation annually, the larvæ wintering in the ground in oval, silken cocoons, the adults appearing about the time pears are in bloom. According to Schmidberger, the eggs are deposited on the anthers of the closed blossom to the number of 10 or 12, and in warm weather hatch in about four days. The young larvæ develop rapidly, penetrating to the core and feeding upon the interior. The affected fruit becomes characteristically deformed. June rains cause it to crack and decay rapidly, thus allowing the larvæ to escape and enter the soil, imagoes developing the following spring.

The recent studies of Mr. C. R. Ball have shown that *Contarinia (Diplosis) sorghicola* Coq. may be responsible for the failure of sorghum to produce a full crop of seed in our southern states. This trouble, Mr. Ball states, has been variously attributed to fungi, insects and unfavorable meteorlogical conditions, such as excessive precipitation, high humidity, severe drought and hot winds. Mr. Ball's experiments showed that heads protected from the midge were uniformly fertile where the growth was normal, while those exposed during the first half of anthesis and then protected were sterile in the upper portion and well seeded below. Mr. Ball succeeded in rearing from 500 to 1,160 midges from each of several infested heads. He also reared a parasite from this insect referable to the genus *Aprostocetus.*

A widely distributed form in the eastern states, *Contarinia liriodendri* O. S., is responsible for a beautiful and characteristic blister gall upon the leaves of tulip, *Liriodendron*. The gall is a nearly circular, somewhat convex blister mine about 5 mm. in diameter. The dark brown center is surrounded by a light brown, irregular area which is slightly darker on its upper margin, the coloration of both surfaces being approximately the same. The partly developed gall has a dark brown, slightly elevated, circular central portion surrounded by pale green, which in turn is encircled by pale yellow, shading into pale green and that again into the color of the normal leaf tissue. This species was first reared by Mr. J. G. Jack and brief descriptions published of the gall, larva and adult in 1889. Mr. Jack's observations show that in the vicinity of Boston there are three or more generations annually, the broods so overlapping that some larvæ may be found at almost any time. He states that the first eggs are probably laid in the spring on the unfolding leaves, while the last larvæ attain full growth about the end of September. The transformations occur in the ground, the late appearing larvæ probably remaining unchanged till spring. This gall insect is so abundant in many places as to seriously affect the foliage of its food plant.

Contarinia ananassi Riley, originally described as *Cecidomyia cupressi-ananassi*, is another member of this genus, chiefly interesting because of the characteristic gall it produces on cypress twigs, *Taxodium distichum*. This gall is a pale brown, sparsely pruinose, ovate swelling on the twig some 1.25 cm. long and bearing numerous transverse, knife-edge-like elevations. This deformity is evidently an enlargement of the growing stem, the transverse elevations corresponding to the leaf scars. The normal fibers of the twig are easily detected in the central portion of the gall, which later may contain from three to eight larvæ in a spongy, golden brown mass. Adults were bred in May and there is probably but one generation annually.

The European *Contarinia rumicis* Low. was bred last July from reddish or brown seeds of curled dock, *Rumex crispus*, taken at Newport, N. Y. Professor Trail states, in the *Scottish Naturalist*, that this species also occurs in the swollen buds of sheep-sorrel, *Rumex acetosella*. This weed is abundant in our section of the country and it is somewhat surprising, if it has this habit in America, that we have not taken this species at large in our extensive collecting during the last two or three years.

Contarinia gossypii Felt is a species which has recently been brought to attention because of its injuring cotton in the British West Indies. No information is at hand as to the precise character of the damage.

Contarinia setigera Lintn. was bred a number of years ago by the late Doctor Lintner, from shoots of musk melon, the young leaves of which had been transformed into a small, irregular, subovate, downy gall, presumably made by this insect.

Contarinia negundifolia Felt MS. was reared from the leaves of box elder, *Negundo aceroides,* collected in Virginia by Mr. Theodore Pergande May 12, 1884. Mr. Pergande states that the larvæ deserted the galls May 15 and entered the ground, remaining there until the following spring. It is possible that this last named species may prove to be identical with *Cecidomyia negundinis* Gill., a species which has been recorded by Professor Gillette as being quite injurious to box elder trees on the college campus at Ames, Iowa. It has been impossible up to the present to obtain for comparison specimens of the last named form.

There are several other American species referable to this genus, some with unknown habits. *Contarinia perfoliata* Felt MS. was bred in August, 1907, from the florets of thoroughwort, *Eupatorium perfoliatum.* Another undescribed species, *Contarinia quercifolia* Felt MS., has been reared from oak, presumably in connection with a Cynipid gall, though we have no exact record in respect to the same. *Contarinia agrimoniae* Felt was reared in September, 1907, from yellowish larvæ in the florets of *Agrimonia eupatoria* taken at Bath, N. Y. *Contarinia virginianiae* Felt, originally described as *Cecidomyia,* was bred June 1 by Dr. James Fletcher, from the deformed fruit of *Prunus virginiana.* Another undescribed species, *Contarinia clematidis Felt* MS., has been reared from an irregular subglobular gall taken on clematis at Newport, N. Y., July 24, 1907.

The above shows that members of the genus *Contarinia,* as at present restricted, display a marked preference for florets, fruits or buds, *C. liriodendri* and *C. ananassi* being marked exceptions thereto, though the latter is more apparent than real, since the gall appears to be developed from the rapidly growing, more tender portion of the twig, which is consequently allied to floral and bud tissues noted above. There seems to be no rule as to the number of generations produced annually by members of this genus. A few forms at least breed throughout the season, while others, apparently limited by conditions presented by the food plant, have but one generation annually. This limitation of the number of generations by conditions of the food plant agrees with observations made upon better known species of the group, such as *Mayetiola destructor* Say.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN OF THE ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

JUNE, 1908

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Reprints of contributions may be obtained at cost. Minor line figures will be reproduced without charge, but the engraving of larger illustrations must be borne by contributors or the electrotypes supplied. The receipt of all papers will be acknowledged.—Eds.

The importance of accurate biological data cannot be questioned, despite the fact that all too frequently it is lacking in the case of some of our common destructive insects. Several years ago Mr. A. A. Girault commenced a series of tabulations of the number of eggs deposited by various species and, thanks to his activity, we have exact data relating to some nine species, the majority of them being of economic importance. These are by no means the only figures in this field, yet they indicate a line of productive activity. Our attention has recently been called to another series of exceedingly timely statistics, in view of the present great interest in parasitic insects. Mr. H. J. Quayle* states that the brown scale, *Eulecanium armeniacum*, is supposed to be controlled by its parasite, *Comys fusca*, its efficiency usually being estimated at 95%. Nevertheless, a statistical study of specimens from 66 different orchards shows a range from 1.9 to 60% in the number parasitized, the average being 12.2%. This study should be continued, as figures for one year are not conclusive. Mr. Quayle calls attention to the fact that other agents are responsible for the destruction of a number of the scale insects, and all too frequently these latter appear to be unnoticed. Parasites have deservedly received considerable attention and occasionally there is no doubt but what they may be responsible for the destruction of 95 or even a higher percentage of their hosts. There is an abundant opportunity for extensive studies of various parasites in order to establish beyond question their true value as natural checks. It is presumable that the work of importing parasites of the gipsy and brown-tail moths will give considerable additional information upon this phase of biological science. There is also great need of more extended information of this character respecting many of our native species.

* Science, May 15, 1908. 27:788-89.

Reviews

Third Annual Report of the Superintendent for Suppressing the Gipsy and Brown-tail Moths, by A. H. KIRKLAND, January, 1908, p. 1–228.

This report is a State document of more than ordinary interest, since it deals with two insect pests of national importance. The local authorities have concentrated their efforts upon keeping the insects in control in the residential sections, while agents of the Federal Bureau of Entomology have given special attention to trees along some 8,000 miles of streets and those overhanging railroads and other lines of travel. The special purpose of this latter line of work is to prevent further spread by means of automobiles. Mr. Kirkland reports a most hearty coöperation as a whole on the part of local officials and citizens. A feature of special interest to entomologists is the condensed data respecting the cost of spraying operations under varying conditions, together with observations upon the adaptability of various forms of spray outfits. The cost of application ranged from $36.25 per acre or approximately 76.3 cents per tree in a woodland consisting of pine and hard wood ranging from 30 to 50 feet in height, and where it was necessary to climb 80% of the trees, down to $2.46 per acre or 3 cents per tree in a woodland along a roadside, with the trees ranging from 20 to 60 feet in height. The first treatment was under adverse conditions, while in the second instance there were comparatively few hindrances. Obviously it will be necessary to continue extensive sprayings for several years at least, and an investigation of the best and most efficient methods is of utmost importance, particularly in woodlands. The report shows that woodlands present a serious problem owing to their low valuation and to the difficulties incidental to treatment. The desirability of more economical methods of fighting the pests in such situations is obvious to all familiar with the conditions. Some interesting data is given concerning the effect of spraying upon bird life, and also the danger to stock where large amounts of poison are applied, particularly with a coarse spray. The ability of the young gipsy moth caterpillars to live upon white pine has been the subject of careful investigations and the indications are that in woodlands where there is a considerable proportion of pine, important modifications in methods may be introduced and the insect controlled with a resultant large saving in the cost of control.

The importation of parasites has been vigorously pushed and a larger number and greater variety obtained than in any preceding year. Large numbers of parasitized individuals of both the gipsy moth and the brown-tail moth were received, the parasites reared and liberated under favorable conditions. This phase of the work has been aptly characterized by Mr. Lounsbury of South Africa as more important than any other feature. Fourteen species of Hymenoptera and twenty-four species of Diptera were bred from the material, several species being liberated in large numbers and some passing the winter of 1906–'07 in safety. Four species of predaceous beetles, two of Calosoma and two of Carabus, have been imported and one at least of the former has wintered in safety.

The most interesting portion of the report to American Entomologists is that part giving the conclusions of various specialists invited to inspect the

work of importing parasites. Representative entomologists, not only from America but from Europe, South Africa and even Australia, personally investigated the methods employed and all unanimously agreed in commending the work in all its phases most highly. There is, in all the reports, unqualified endorsement of the Superintendent for placing the execution of this work in the hands of Dr. L. O. Howard, Chief of the Bureau of Entomology. Furthermore, several have taken the pains to look into the proposition made several years ago by certain Western parties, and have unhesitatingly given a decision in favor of the work being conducted by the party now charged with its execution. Certain suggestions were made by various entomologists, such as further investigation of fungous diseases, the importance of the biological study of the various parasites, and in particular, the advisability of securing certain parasitic enemies of the gipsy moth known to exist in Japan. It is gratifying to state that the wisdom of most of these suggestions had been previously recognized and that steps have already been taken for the carrying out of some. This investigation by independent entomologists from widely separated localities should settle for all time any hostile criticism of the methods now employed. Ample funds should be made available for the work with parasites, because if it is worth doing at all it is worth doing thoroughly. No stone should be left unturned in the search for efficient enemies of these two destructive insects.

The report as a whole is most commendable, presenting a maximum of information in a minimum of space, and in a most accessible form. There seems to be but one omission, namely, some statement as to the territory now occupied by the brown-tail moth. E. P. F.

Seventh Report of the State Entomologist, by W. E. Britton. Report of the Connecticut Agricultural Experiment Station, 1907, Part 5, p. 265–338.

This report contains several valuable contributions. One on various gases for fumigating nursery trees, a summary of which was given before the Chicago meeting of the Economic Entomologists and is published on p. 110–12. The results of experiments with different brands of soluble or miscible oils are given, showing an efficiency varying from 95.7 to 100 per cent. There is a detailed, well illustrated account of the new peach sawfly, *Pamphilius persicum* MacG., an insect which may prove of considerable economic importance. The work of exterminating a small colony of gipsy moths is described in detail. Indications are that it will be successfully accomplished within the next two or three years. The recent enactment concerning this pest is also included. Chemical analyses of lead arsenate and Paris green, previously published as a bulletin, form a part of the report. Observations are also given on a number of species injurious during the year.

E. P. F.

The So-Called Grain Bug and Other Grain Aphids in Minnesota in 1907, by F. L. Washburn. Special Report of the State Entomologist of Minnesota, March, 1908, p. 1–21.

This special report gives a summarized account of the grain aphid, *Toxoptera graminum*. The differences between the various species are well brought

out by illustration as well as description. The author is to be congratulated upon having produced a most admirable account of this insect and its allies, the typography and illustrations being most excellent.

E. P. F.

Gipsy and Brown-tail Moths, by E. DWIGHT SANDERSON, N. H. Agricultural Experiment Station, Bull. 136, 1908, p. 93–156.

This bulletin gives the distribution of both species in New Hampshire. The gipsy moth occupies the southeastern corner of the State, while the brown-tail moth may be found over most of the southern third, having greatly extended its range. Excellent general accounts, with a number of original illustrations, are given of both species, together with the recently enacted law.

E. P. F.

Current Notes

Conducted by the Associate Editor

Mr. Z. P. Metcalf, Assistant Entomologist to the Michigan Agritural Experiment Station, has been appointed Assistant Entomologist to the North Carolina State Board of Agriculture, and will enter upon his new duties June 20.

Mr. S. C. Clapp has been appointed Inspector of Nurseries and Orchards for the Division of Entomology of the North Carolina Department of Agriculture, to succeed Mr. L. M. Smith, resigned. Mr. Clapp is a native of North Carolina and has had considerable experience in general nursery and insecticide work.

Mr. Ed. Kinney has begun work as Assistant in Entomology and Botany at the Kentucky Agricultural Experiment Station. Mr. Kinney has been a student at the Ohio State University and will take the degree of Bachelor of Scientific Agriculture at the end of the present year.

Mr. C. F. Jackson, A. M., Assistant in Zoölogy and Entomology at the Ohio State University, has been elected Assistant to the Entomologist in the New Hampshire Agricultural Experiment Station.

Mr. N. E. Shaw, a graduate of the Ohio State University, who has previously been employed as an Assistant Inspector by the Ohio State Board of Agriculture, was elected Chief of the Division of Nursery and Orchard Inspection, and assumed his duties April 1. Mr. W. E. Evans, a graduate of the same institution, has been retained as first Assistant Inspector.

Mr. J. B. Parker, A. M., Ohio State University, has been elected Assistant Entomologist in the Kansas Agricultural Experiment Station, and took up the work May 1.

The summer session of the Lake Laboratory of the Ohio State Uni-

versity will open June 22. An excellent course in Entomology is offered and abundant opportunities are provided for research work. The Laboratory is located at Cedar Point, near Sandusky, Ohio. Full information concerning courses can be secured by writing to the Director, Prof. Herbert Osborn, Ohio State University, Columbus, Ohio.

Mr. A. C. Baker of the Agricultural College, Guelph, Ontario, Canada, has been appointed Assistant in Entomology at the Minnesota Agricultural Experiment Station.

Mr. L. M. Peairs, a graduate of the Kansas Agricultural College, has resigned as Assistant to the State Entomologist of Illinois and has accepted the position of Assistant Entomologist to the Maryland Agricultural Experiment Station.

Mr. Franklin G. Fox has resigned as Assistant in Apicultural Investigations in the Bureau of Entomology, Washington, D. C., and the position has been filled by the appointment of Mr. Arthur H. McCray, a member of the senior class at the Ohio State University.

Mr. R. W. Braucher, a graduate of the University of Illinois, has been appointed an Assistant in the Bureau of Entomology, and will be engaged in the investigation of deciduous fruit insects.

Mr. A. G. Hammer, a post-graduate student at Cornell University, has been appointed an Assistant in the Bureau of Entomology, and will work on deciduous fruit insects.

M. A. Vuillet, who is an Assistant to M. Rene Oberthur, at Rennes, France, has been secured by Dr. L. O. Howard to rear parasites of the gipsy and brown-tail moths at that place and forward them to the gipsy moth laboratory at Melrose Highlands, Mass., for distribution in the moth infested district.

Dr. Wm. M. Wheeler, Curator of Invertebrate Zoölogy in the American Museum of Natural History, has been appointed Professor of Economic Entomology in the Graduate School of Applied Science of Harvard University.

Mailed June 15, 1908.

with a membranous and semi-opaque shell, and 1.5 mm. long. He says in his report: "The cavity was lined with a reddish, glossy material, which seemed to be a thin skin, separable from the woody tissues. The sap was just beginning to run and the tissues were full of it."

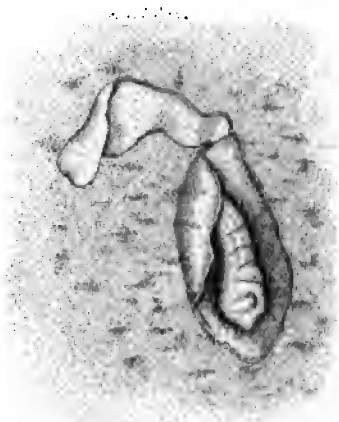
FIG. 6. Nymph of *Empoasca mali* within the pouch, the covering epidermis being turned back, much enlarged (original).

Of course, it yet remained to be proven that the above egg was that of *Empoasca*. No more eggs were found until May 24th, when Mr. R. L. Webster, in charge of the insectary and a part of the field work for the department during the summer, found them quite numerous in three-year old apple stock in a southern Minnesota nursery. He reports these eggs as being somewhat smaller than those found at St. Anthony Park, measuring .4 and .75 mm. Mr. Ainslie's description applies so well to the later found eggs that there is but little if any doubt of their being those of the same species. All these "blisters" or pouches containing eggs were found on old wood in the upper part of the trunk, and none on the small twigs, and their general shape varied from that of a fresh water mussel or clam shell to almost cylindrical.

A small tree showing a number of these blisters was taken into the insectary, and there a young *Empoasca* was observed in the act of emerging. This specimen died before becoming free from the blister. A sketch was made at the time by our artist, showing the bark cut back and the body of the larva below.

We cannot speak of the location of the summer egg with as much certainty as we can of the winter egg, although putting the evidence in our possession with that of others, we are inclined to the belief that the petiole and mid-rib, as well as the leaf itself, may be the places chosen for oviposition on the apple by the females of the summer generations, for Ainslie found on June 25th an enlargement on a petiole which contained the remnant of an egg shell, and on September 4th Webster found a swelling in a leaf similar to that which characterized the presence of the winter eggs. Only one was found. Webster describes it as 5 mm. long, slightly brown, with a slit in one end.

On September 19th in a large nursery, Mr. Ainslie examined a number of one year old apple trees. These trees were almost hidden in a

N. B.—Insert in place of pages 143, 144.

growth of buckwheat planted for winter protection. The plot had been infested with leaf hoppers earlier in the season, and a few were still in evidence. Every portion of the bark of several trees was examined most thoroughly with a hand lens without result, but on a few petioles slight discolorations, accompanied in each case by an elevation of the epidermis, were found. These were so small that they were hardly visible to the naked eye, and were for the most part located on the side of the petiole, and on the half nearest the leaf. One was found on the under side of the mid-rib. *Empoasca* larvæ were found on the above trees, and the spots on the petioles were, according to Ainslie, the only abnormal thing about the trees.

The buckwheat growing amongst these trees was also examined, and two similar discolored swellings found on petioles. At this date there were very few *Empoasca* on the trees, but they were numerous on the buckwheat. Dissection of some of this material on November 9, preserved in alcohol since September 19, and not in very good shape, disclosed nothing of which we can speak definitely.

While[1] we have found no actual proof, showing the location of the eggs of the summer broods, it seems probable that they are laid on leaf or petiole, as is the case with *Typhlocyba comes.* As if in corroboration of Dr. Forbes' observation, Mr. Webster found on the under side of an apple leaf a swelling similar to that in which the winter eggs were found on the bark. This was found September 4th, and was the only one discovered. The swelling was .5 mm. long, slightly brownish in color, with a slit in one end. I propose during the coming summer to obtain some light upon this phase of the subject, and also upon the date of egg laying by the last brood in the fall.

Insectary records of the stages of *Empoasca* show a record of from nineteen to twenty-five days as nymphs, and five nymphal stages between egg and adult. It was practically impossible for us to determine the length of each instar exactly, but it may be safely said that the first brood nymphs have longer instars than those in the following broods. The average lengths of individuals in the successive nymphal stages are as follows: First stage, .8mm.; second, 1.3 mm.; third, 1.7 mm.; fourth, 2.1 mm.; fifth, 2.4 mm., and the adult 3.1 mm.

Mr. Webster reports observing these hoppers hopping in the last nymphal stage, in several instances leaping a distance of over a foot.

[1] Owing to an unfortunate duplication of matter, pages 143 and 144 have been reprinted so they can be inserted in corrected form when binding the volume. Prof. Washburn kindly supplied the above paragraph to fill an awkward vacancy.

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THE FIRST AND LAST ESSENTIAL STEP IN COMBATING THE BOLL WEEVIL[1]

By W. E. Hinds, Ph. D.

The Problem of Weevil Control

Statement of the Problem.—During the past fifteen years the Mexican cotton boll weevil has spread throughout Texas, northward to about the middle of Oklahoma and southeastward from that region through southern Arkansas nearly to the Mississippi River, then southward through Louisiana, covering practically the entire western portion of the state and even spreading across the river into a few of the southwestern counties of Mississippi. Nothing seems likely to permanently check its eastward movement throughout the other cotton-growing states. It now infests practically one half of the cotton-growing area and is doing damage which can hardly be estimated at less than $25,000,000 a year.

To the entomologist the practical problem is that of reducing the injury within the infested area to the smallest possible amount and to restrict the spread of the pest so far as it may be within human power to do so by the enforcement of quarantine regulations to prevent its being carried long distances into uninfested territory by commercial agencies.

Brief Survey of the Results of Investigational Work on Control

Factors in Natural Control.—These factors are, by their very nature, inconstant and unreliable, although they may often be of prime importance and are apparently of generally increasing value. The uncertainty of climatic factors which are sometimes of greater im-

[1]Read before the Association of Economic Entomologists, at Chicago, Ill., December, 1907.

portance than any others need only be mentioned as an illustration of this class. The general difficulty is that we cannot tell what their effect may be until it becomes too late to take proper advantage of the conditions which they produce.

Natural enemies, both predaceous and parasitic, may also be valuable allies in the fight and every advantage possible should be taken of them, but it is simply folly for the cotton planter to sit idly by trusting nature to do all of the control work for him. However, it is certain that we would have a much more hopeless task in attempting control without the help of these natural factors and we may well study object lessons of the strongest kind, which nature frequently gives us as practical effects which man may himself, in some measure, reproduce.

Methods of Direct and Indirect Combat.—Naturally, through their general applicability to similar problems, the first recourse of the entomologist and of the planter as well is to insecticides. It is sufficient to say that "hosts" of these, both promising and otherwise, have been carefully tested and invariably found practically useless in fighting the weevil. The most promising and also widely tested of them all is Paris Green dusted on the young plants at intervals beginning before squares form, but its use has proven so constantly disappointing when applied that it has been practically abandoned by entomologists and by most planters.

The real reason for failure with Paris Green applies with equal force to all other arsenicals and to contact insecticides as well. Owing to the practical impossibility of applying it to those partially protected places where the weevils normally feed, only from one third to one half, on the average, of the adult weevils on the plants at the time of the treatment can be killed. The very long period of emergence from hibernation makes the number of weevils on the plants at one time but a very small fraction of the entire number which may survive and attack the crop. This renders frequent treatments necessary and their effectiveness is only partial at best. The immature stages cannot be reached by any insecticide, as they are surrounded constantly by several layers of vegetable tissue, and to penetrate that would require a power in the insecticide that would be fatal to the plant. Repeated applications of dry Paris Green (and of other insecticides as well) will often do more damage to the crop through its harmful effect upon the growth of the plant than would the weevils if allowed to do their worst.

No method of applying any efficient fumigant has been found applicable to a field crop like cotton. Small-scale experiments with the leading fumigants have indicated that none of them could be de-

pended upon to kill the immature stages even if they would kill the adults.

Trap rows are rendered impracticable by many considerations, but especially by the period of emergence from hibernation extending far beyond the time of any practicable delay in the planting of the main crop.

Among the multitude of machines devised, most have been designed for collecting and destroying the adults, or both adults and the infested fruit. Although some of them have been built at great expense and with the best of mechanical skill, none has yet proven superior to the practical difficulties encountered in field operation. It may be said fairly that there is not now on the market a practicable machine for combating the weevil. It is possible that the most promising device of this nature is one originated by the writer during the latter part of the season of 1907, which is now being patented by the Department of Agriculture. But this machine has not yet been tested upon a sufficiently large scale to justify its commendation for general use. However, it belongs rather to the methods of cultural control, since it combines the action of drawing the fallen, infested forms to the centers of the paths where the weevil stages will be mostly destroyed by the action of the direct sunshine, with the coincident cultivation of the crop.

The constant failures experienced in applying any direct method of attack have made it necessary that primary reliance for the control of the weevil should be placed upon indirect methods of cultural control which have as constantly given more encouraging results. It is now more than ten years since Dr. L. O. Howard first suggested the importance of cultural methods in fighting this insect. Ever since that time in all of the extensive work which has been carried on by the agents of the Bureau of Entomology, particular attention has been given to this phase of the problem. The general recommendations worked out by the agents of the Bureau have been frequently repeated in various publications and are now widely known. They have also been demonstrated in a practical way through the Demonstration Farm work carried on by the Bureau of Plant Industry. There is evident a large increase in the proportion of the most progressive planters who have adopted part, if not all, of these recommendations. There can be no adequate measurement of the value of the results of this work already obtained and it is equally certain that the possible good results are only beginning to be realized.

In the best sense of the word, the methods advocated for the cultural control of the weevil constitute a "system." The various steps

are so interdependent that securing the full benefit from any one of them involves the adoption of many of the others. A careful consideration of each step, both as to its independent and interdependent effectiveness seems to justify the broad general assertion that the early fall destruction of its food-supply—cotton—may reasonably be called, as it has frequently been, "the most important step in the cultural system of controlling the weevil." The exhaustive studies which have been made by the field agents of the Bureau on all phases of the life and seasonal histories and upon natural and artificial control of the weevil indicate that the few weeks which may intervene between the maturity of the bulk of the crop and the time that is most favorable for the weevils to enter hibernation constitutes the strategic period for largely reducing the number of weevils which may survive hibernation and attack the crop of the following season. The application of all other steps in the system recommended is designed primarily and ultimately to render this period as long as possible and to thereby increase the practical possibility of the general adoption of this step as the final and most important thing in the work of each season, and thus open the way for the most successful results with the culture of a cotton crop with the minimum of weevil injury during the following year.

The most convincing experiments showing definitely the possibilities of and urgent necessity for the adoption of this plan and also a large-scale field demonstration of the great, practical benefit obtainable in a community by its general adoption, have been accomplished during the past year. A full account of the experimental work is being published by the Bureau of Entomology under the title of "Hibernation of the Cotton Boll Weevil" by Mr. W. W. Yothers and the writer.

Having given but a very brief and partial view of the general problem which the presence of the boll weevil inevitably presents and of the general results of the investigation to secure feasible methods of control, the writer would add a brief summary of the data which support the conclusions stated as to the essential value of stalk destruction. For the sake of brevity much important work cannot be mentioned here. The extensive hibernation experiments of 1906–'07 will alone be considered, although mention may be made of the general results of other investigations when needed for comparisons.

Principal Data Indicating the Importance of Stalk Destruction

Hibernation Work of 1906 '07. Some knowledge of the general plan and purpose of this work seems essential to a clear understanding

of its value and a correct interpretation of the results observed. Three localities, Dallas, Calvert and Victoria, Texas, were selected for experimental work, as these represented in a general way the northern, central and southern sections of the state, and considerable work of a similar nature had been done at each place which might serve as a check or for comparison. At each place was erected a cage 20 x 50 feet and 6½ feet high, covered with 14-mesh, galvanized wire screening and having cross-partitions so as to form ten sections, each having a ground area of 100 square feet. · The three localities offered a considerable range in geographical and climatic conditions. It was planned to provide similar shelter conditions in corresponding sections and to enclose weevils in each section upon as nearly the same date in each locality as might be possible. The weevils used were collected in the immediate locality and from 1,000 to 4,000 were placed in each section, making a total of over 75,000 in the three cages. Observations were made at intervals, from the time weevils were placed in the cage until the beginning of the general emergence movement in the spring, and daily thereafter. Suitable and reliable data as to climatic conditions were secured by providing standard types of weather bureau instruments in a shelter erected beside the cage in each locality. Temperature, rainfall, humidity and other records were thus kept throughout the period covered by the experiments. In this way it was anticipated that data might be obtained bearing especially upon the following points:

1. The effect of the time of entrance into hibernation upon the survival of weevils. In the first experiments either entrance upon hibernation or starvation was forced by the destruction of the food supply. The geographical range would naturally increase the interval between the beginning of the experiment and the time when weevils would naturally enter hibernation at each locality.

2. The effect which the complete destruction of the food supply at varying dates might have upon the success of hibernation. For these experiments the shelter conditions were made as uniform and as favorable as it was possible to make them in the different localities. It was hoped by these tests to determine the minimum interval which must elapse between the destruction of food and the successful hibernation of the weevils.

3. To determine the effect of exceptionally favorable and unfavorable conditions of shelter upon the successful hibernation of weevils placed in the corresponding sections upon the same date in each locality. It was intended that the shelter conditions provided should be so exaggerated as to represent the extremes of conditions which might naturally occur in or around the fields.

4. To determine the effect which varying depths and classes of shelter might exert upon the success of hibernation and also upon the time of beginning and the range in the period of emergence from hibernation.

5. To test the power of adaptation to climatic variations by bringing weevils from widely separated localities and hibernating them for comparison with weevils collected at Dallas. In each section food and shelter conditions were to be similar.

6. To determine upon a large scale and in widely separated localities and under various conditions of shelter the proportion of weevils entering hibernation which might survive.

7. To determine the relation of climatic conditions to the emergence period in each locality.

8. To determine the longevity of hibernated weevils after emergence both with and without food.

In the following table are summarized the principal points relating to the installation of the experiments for this season:

Table I. Installation of hibernation experiments, 1906-1907

No. of Section.	Date of Starting Experiments, 1906.			Character of Shelter Supplied.	Conditions as to Food Supply.
	Dallas.	Calvert.	Victoria.		
1	Oct. 13	Oct. 13	Oct. 25	Leaves and grass 4-5 in. deep.	All cotton removed after two days.
4	Oct. 16	Oct. 19	Oct. 25	do.	Stalks cut and left.
2	Oct. 19	Nov. 26	Oct. 28	do.	Food removed after two days.
7	Oct. 25	Oct. 25	Nov. 6	Spanish moss hung around top of cage. Loose bark on ground.	Food present; cut and allowed to dry.
8	Oct. 31	Oct. 31	Nov. 10	Leaves and grass 4-5 in. deep.	Food removed after two days.
5	Nov. 6	Nov. 5	Nov. 14	do.	Cotton cut and allowed to remain and dry.
3	Nov. 12	Nov. 14	Nov. 21	Leaves and grass two inches deep.	do.
9	Nov. 12	Nov. 12	Nov. 21	Leaves and grass ten inches deep.	do.
6	Nov. 28	Nov. 25	Nov. 28	Ground absolutely bare.	No food supply.
10	Dec. 6 and 10	Dec. 3	Nov. 29	Three bushels, probably, infested bolls on surface of half of cage and 3 bushels buried under 2 inches dirt in other half	do.

Having now followed the beginning of the experiments, it is in order to note the climatic conditions prevailing throughout them. Temperature records were the most abnormal and also the most significant and therefore only those are given in Table II

Table II. Mean monthly temperatures and departures from normals at Dallas, Calvert and Victoria, Texas, November, 1906, to June, 1907, inclusive

Locality, Texas.	November.		December.		January, 1907.		February.	
	Monthly mean °F.	Departure °F.	Monthly mean °F.	Departure °F.	Monthly mean °F.	Departure °F.	Monthly mean °F.	Departure °F.
Dallas	54.8	—0.6	51.6	+3.8	58.4	+8.5	51.2	+6.6
Calvert	59.1	+0.1	56.8	+4.1	59.8	+9.6	54.8	+2.9
Victoria	62.9	—1.8	59.2	+1.4	63.4	+9.8	60.2	+6.2
	March.		April.		May.		June.	
Dallas	66.7	+11.1	61.4	—4.2	65.8	—7.7	78.8	—1.9
Calvert	70.0	+ 9.2	62.2	—5.9	66.6	—7 3	76.6	—4.4
Victoria	72.4	+ 9.7	69.4	—3.8	73.0	—5.0	81.6	—0.6

The columns giving the departures from normals are particularly significant as showing the very unusually warm winter and early spring and the exceptionally cold period following. It was actually much warmer in March throughout Texas than during April and May. These facts account for the unusually large percentages of survival, the remarkably early beginning of emergence and the long duration of the emergence period. At no time during the winter was hibernation complete anywhere in Texas. Weevils were active both in the cages and in the fields. This has never happened before, except rarely in extreme southern Texas.

Next in order will be the consideration of the general results of the observations upon the survival of weevils.

Table III. Summary of Emergence records from hibernation experiments, 1906-1907

Locality, Texas.	No. of Weevils put in Cages.	No. of Weevils as basis for determining per cent. of Survival.[1]	No. Weevils Emerged.	Per cent. of Survival.
Dallas	32,439	30,864	3,464	11.22
Calvert	20,430	19,408	1,842	9 49
Victoria	23,645	22,463	3,026	13.47
Totals	76,514	72,735	8,332	11.45

It is probable that 11.5 is the largest percentage that has ever survived in Texas considering so large an area. In the experiments of

[1]Basis for computing percentage of emergence is 5% less than the number placed in the cage to allow for the escape of some through the wire.

the preceding season at Keachie, La., and Dallas, Texas, among 35,-900 weevils, the average survival was only 2.18 per cent. The emergence movement began on March 22 and continued until June 28, 1906. These are unquestionably closer to the normal facts regarding emergence than are the figures shown in 1907. We have thus in two seasons a range in percentage of survival of from 2 to 11 per cent and in emergence from February 15 to the end of June. These facts emphasize very strongly the importance of reducing the number of weevils entering hibernation.

In order to make the following facts represent general conditions and avoid the possibility of being misled in our conclusions by the variations which might reasonably occur in a single experiment, we shall present the data in groups of experiments and base our conclusions upon the average results shown by the totals and average percentages for each group. The chronological significance of the data may be most clearly shown by grouping the records for those localities at which experiments were started upon the same or approximate dates. The shelter and food conditions represented in each group are therefore fairly averaged and the time at which the experiments were started becomes the most significant factor in each group. The desired comparisons can be most briefly shown by tabular arrangement.

In Table IV it may be seen that averaging all localities at which weevils were started upon approximately the same date, there is a most striking increase in successful survival from the middle of October to the middle of November. In the interval of eleven days from October 14 to 25 the percentage of survival practically doubled. During the next ten days the percentage again doubled and a corresponding increase is observable between November 5 and 14. After that time hibernation might have been successful for practically the maximum possible proportion of weevils. The first freeze occurred on November 18. The facts shown may appear more emphatic if stated in another way. Under otherwise similar average conditions, the chances for survival for weevils in Texas in 1907 were: On October 15, one; October 25, two; November 5, four; November 15, six. These facts make it plainly evident that from October 15 to November 15 constitutes the *strategic period* for attack upon the boll weevil. The data and conclusions are here given that they may be studied carefully by those who are interested to do so.

Conclusions Drawn from Data Presented

Application of Conclusions. The method of attack which has proven most effective consists of the successive steps constituting the

Table IV. Effect of time of entrance into hibernation, or isolation from food supply upon survival of weevils

Date, 1906	Locality, Texas.	Section Number.	No. Weevils Present.	No. Weevils Emerged.	Per cent. of Survival.	Rank of Group in Survival.	Remarks.
Oct. 13	Dallas	1	3,800	99	2.61		
Oct. 13	Calvert	1	2,375	75	3.15		
Oct. 16	Dallas	4	2,090	85	4.07		
Totals for group		3	8,265	259	3.14	8	
Oct. 19	Calvert	4	2,375	116	4.88		
Oct. 20	Dallas	2	3,610	226	6.26		
Totals for group		2	5,985	342	5.71	7	
Oct. 24	Dallas	7	3,325	231	6.95		
Oct. 25	Calvert	7	2,375	105	4.42		
Oct. 25	Victoria	1	2,375	201	8.46		
Oct. 25	Victoria	4	2,375	105	4.42		
Totals for group		4	10,440	642	6.15	5	
Oct. 28	Victoria	2	2,389	134	5.61		
Oct. 30	Dallas	8	2,850	250	8.85		
Oct. 31	Calvert	3	2,375	63	2.65		
Totals for group		3	7,614	447	5.87	6	
Nov. 5	Dallas	5	3,135	383	12.22		
Nov. 5	Calvert	5	2,375	45	1.89		
Nov. 6	Victoria	7	2,850	674	23.65		
Totals for group		3	8,360	1,102	13.18	4	
Nov. 10	Victoria	8	2,850	362	12.70		
Nov. 12	Dallas	3	3,040	448	14.74		
Nov. 13	Dallas	9	3,040	788	25.92		
Nov. 14	Calvert	9	2,375	438	18.44		
Nov. 14	Victoria	5	2,850	449	15.86		
Nov. 15	Dallas	11	2,565	804	31.34		
Totals for group		6	16,720	3,284	19.67	2	
Nov. 21	Dallas	12	1,570	65	4.14		Brownsville Weevils.
Nov. 21	Victoria	9	2,836	374	13.19		
Nov. 21	Victoria	3	2,850	588	20.63		
Totals for group		3	7,256	1,027	14.15	3	16.91 % without B. W.
Nov. 25	Calvert	6	1,425	359	25.19		
Nov. 26	Calvert	2	1,358	380	27.98		
Nov. 28	Dallas	6	975	46	4.72		(Absolutely bare ground.)
Nov. 28	Victoria	6	1,088	139	12.78		
Totals for group		3	4,846	924	19.07	1	(22 % without Dallas lot.)

Cultural System. Having secured an early maturing crop, it should be picked out as soon as open, the earlier the better. If not all gathered before October first in South Texas, every effort should be put forth to clean up the fields by that time and the few late opening bolls should not be allowed to delay the immediate destruction of the stalks in some thorough manner. In the southern part of the state where sprout cotton commonly occurs, great care should be taken to destroy enough of the roots to prevent any sprouting in the spring. Clean

the fields as thoroughly as possible, including the turn-rows and along ditches and fences and under timber fringes. This thorough treatment is even more essential in south than in north Texas, although in the latter portion of the state it seems advisable.

As has been frequently pointed out, this early fall destruction prevents absolutely the further breeding of weevils and many of those partly developed in squares or bolls will not be able to mature. The late developed weevils are most liable to hibernate successfully. By destroying the most favorable shelter which the weevils that escape destruction could possibly find, the chances of their surviving the winter are greatly lessened. In a variety of ways, therefore, the actual number of weevils entering hibernation becomes very greatly reduced and the chances of the successful hibernation of those entering are correspondingly decreased. The number of weevils ready to attack the crop the following spring would, with these practices, be but a small fraction of what might otherwise be present.

The Demonstration.—That these conclusions are correct and practicable has been proven by actual field application on a large scale. At Olivia, Texas, in the fall of 1906, about twenty planters on adjoining farms were persuaded to enter into agreement to do this work by Mr. J. D. Mitchell. All stalks were destroyed upon an area of about 40 acres between October 1 and 10. This area was well isolated from other cotton, but had been badly infested up to that time. A check area some six miles away across a bay received the usual treatment. No special treatment was given to the Olivia tract during 1907. In spite of the fact that the survival of weevils, as has been shown, was unprecedented during this intervening winter, they did not become numerous enough to do any considerable damage to the Olivia crop, while on the check area they were exceedingly injurious. Although the Olivia crop was grown on soil that was not as rich as that in the check, it yielded more than 1,000 lbs. of seed cotton per acre, whereas the check yielded but about 300 lbs. per acre. The difference in value of these two crops was fully $20 per acre, or more than enough to pay for the land upon which the crop at Olivia was grown.

The Difficulties. If there were no obstacles in the way of an easy adoption of these recommendations, it is not likely that the same necessity for them would exist. Any prospect for a late "top crop" of cotton is removed by the presence of the weevils. Every experience shows that the crop must be made early. The difficulty of getting sufficient labor is great in some sections. It is evident that there is necessity for the production of an efficient machine for cotton picking to meet this need. The actual destruction of stalks may be accom-

plished in any way possible so long as the desired results are obtained. The question is not one of method but of results. More particulars as to time and methods are given by Mr. W. D. Hunter in Circular 95 of the Bureau of Entomology. It is certain that the individual adopting the Cultural System may reap a large share of its benefits regardless of the lack of coöperation on the part of his neighbors, but it is desirable that a strong sentiment should be fostered which shall lead to united action over considerable areas. It is to be hoped that the practical difficulties presented by the tenant system may be overcome, so that every tenant will be led (or forced if need be) to consider that his season's work is not complete until he has added this step to the harvesting of the crop. This idea would be welcomed if there could be a general understanding by landowners and tenants of the fact that fields thus treated will produce better yields, as a rule. They would be better inducements to securing a good class of tenants, and such tenants having cleared their fields in the fall would be less likely to move.

The question here presented is a vital one for the weevil-infested area. It demands not merely acquiescence, but action. The accuracy of the facts presented cannot be questioned, but each man must decide for himself as to the correctness of the conclusions. To us it appears that this statement does abundantly justify the broad, general conclusion that "the DESTRUCTION OF STALKS BY SOME EFFECTIVE METHOD AND AS LONG AS MAY BE POSSIBLE BEFORE THE NORMAL TIME FOR WEEVILS TO ENTER HIBERNATION CONSTITUTES THE MOST EFFECTIVE METHOD NOW KNOWN OF REDUCING THE SEVERITY OF THE WEEVIL ATTACK UPON THE FOLLOWING CROP AND THAT IT THEREFORE DESERVES GENERAL RECOGNITION AND ADOPTION AS THE LAST STEP IN THE TREATMENT OF EACH SEASON'S CROP AND ESSENTIALLY THE FIRST STEP ALSO IN THE PRODUCTION OF A CROP WITH THE MINIMUM WEEVIL INJURY DURING THE FOLLOWING SEASON."

Grape Blossom Midge

Cecidomyia johnsoni Sling. This species, unknown as an adult, caused exceptional injuries at Fredonia, where it destroyed 60% to 75% of the blossoms on one acre of Moore's Early grape. The work of this species has been known for years, and the familiar galled blossoms were easily found throughout the entire Chautauqua region. The work above described is undoubtedly due to exceptional conditions and is probably explainable by the blossoms being in just the right stage of development at the time when a large number of the midges were flying. Repeated attempts to rear the adult have been unsuccessful, though it is probably referable to the genus *Cecidomyia*.

E. P. FELT, Albany, N.Y.

A NEW PREDACEOUS ENEMY OF THE COTTON BOLL WEEVIL

WILMON NEWELL and R. C. TREHERNE, *Baton Rouge, La.*

So far as known to the writers there is no published record of any Carabid which attacks the boll weevil, *Anthonomus grandis* Boh.

While conducting some experiments with boll weevils in cages, during May of the present year, it was noticed that the adult weevils in one cage disappeared with remarkable rapidity. It may be remarked, by way of parenthesis, that in cages of the character used, weevils dying in the cages are usually found with ease on the ground around the growing plants. Especially is this true when daily examinations of the cages are made. In the cage referred to but few dead weevils could be found and the mortality among the weevils confined therein was several hundred per cent higher than the mortality in other cages under similar conditions. Upon close examination of this cage upon May 11th a small hole was noticed in the earth in one corner of the cage and at a depth of five inches in this hole was found a live Carabid together with elytra and other fragments remaining from the destruction of at least nine boll weevils.

This beetle we have identified as *Evarthrus sodalis* Lec., and from the number of weevil remains found with it, it seems not improbable that boll weevils constitute an important part of its food in the weevil-infested section.

A few days later another species of *Evarthrus*, as yet undetermined, was captured and placed in a glass jar with several live boll weevils. In the course of a few hours this Carabid caught and ate two of them.

It therefore seems that the several species of this genus may be regarded as probable enemies of the boll weevil and the part played by them in the natural control of the latter insect may prove to be of some little importance.

Baton Rouge, La., June 27, 1908.

THE INFLUENCE OF MINIMUM TEMPERATURES IN LIMITING THE NORTHERN DISTRIBUTION OF INSECTS[1]

By E. DWIGHT SANDERSON, *Professor of Zoölogy and Entomology, New Hampshire College; Director and Entomologist, New Hampshire Agricultural Experiment Station.*

For the past three winters the mortality of the larvæ of the browntail moth (*Euproctis chrysorrhoea*) in their winter nests has been determined by my students at different dates. January 24, 1907, the temperature dropped to —24°F. at Durham, N. H., the lowest tem-

TABLE I.[2]

Locality.	Date counted.	Minimum degrees F.	Per cent. dead.	Number nests.	Average number larvæ per nest.	Remarks.
Durham, N. H..	Jan.-Mar. 1905........	—17	23	5	271	18 to 39 % dead.
Durham, N. H..	Jan.-April 1906	—11	5	58	218	0 to 90 % dead.
Durham, N. H..	Dec. 12-Jan. 23, 1907 ..	— 6	6.7	51	374	
Durham, N. H..	After Jan. 24, 1907	—24	100	75	401	Nests from apple, etc.
Durham, N. H..	After Jan. 24, 1907	—24	57	5	922	Nests from tall oaks.
Lewiston, Me...	Mar. 15, 1907...........	—24	72	15	289	
Bath, Me........	Mar. 23, 1907...........	—20	87	15	262	Temperature calculated
Rockland, Me..	Mar. 15, 1907...........	—20	51	15	325	from isotherms of Map 1.
Bar Harbor, Me.	Mar. 15, 1907...........	—19	43	14	282	
Portland, Me ...	Mar. 15, 1907...........	—16	98	15	464	
Franklin, N. H..	Feb. 20, 1907..........	—18	54	15	336	
Newton, N. H ..	Feb. 20, 1907...........	—15	27	10	468	
Nashua, N. H ..	Feb. 20, 1907...........	—13	8	15	608	Large nests on elm, oak.
Concord,[3] N. H.	Feb. 20, 1907.....	—12	21	15	342	

[1] A paper read before the section of Economic Zoölogy, of the seventh International Zoölogical Congress, Boston, 1907.

[2] Since the above was written and Map 1 prepared I have received the following data through the kindness of Prof. E. F. Hitchings, State Entomologist of Maine, under whose direction the counts of mortality in the nests were made. (See page 246.)

[3] Nests were also received from Ossipee, N. H., where the temperature must have gone below —20° F. (see Map 1), in which all the larvæ were dead, and no live larvæ were found in nests at Ossipee according to a resident there.

perature recorded there,[1] and absolute minimum temperatures were also recorded at Orono, and other points in Maine. Nests were immediately collected from various localities in New Hampshire and Maine. The mortality record is given in the preceding table.[2]

Locality.	Lowest temperature, degrees F.	Per cent. dead.	Number nests.	Average number larvæ in nest.	Largest number larvæ in nest.
Portland,[3] Me	—22 (—16)	68	10	[illegible]	[illegible]
Riggsville, Me	—20	11	10	315	[illegible]
Rockland, Me	—28 (*—20)	88	10	[illegible]	778
Prospect Harbor	—20	94	10	278	[illegible]
Oxford, Me	—20 (*—25)	66	10	282	[illegible]
Mechanic Falls	—20 (*—25)	71	10	282	426
Augusta, Me	—42 (—41)	100	10	264	[illegible]

These counts show that where average size nests of 300 to 400 larvæ were subjected to —24° F. or lower, that from 72% to 100% were killed, but that in large nests on oak from the same locality only 57% were killed. That the total mortality of the larvæ in the nests from Durham, N. H., after —24° F. on January 24, 1907, was due to the low temperature is demonstrated by there having been but 6.7% dead in 51 nests up to that date, when the mortality at once dropped to 100%. The detailed records of the individual nests show this absolutely.

[1] —24° F. was the official record of the station thermometer, but several thermometers in the town, whose accuracy need not be doubted, recorded —30° to —35° F.

[2] The counts of the nests were made under the immediate supervision of my assistant, Dr. T. J. Headlee, who gave the matter most careful attention and who has prepared the preceding summary, Table I.

[3] It is noticeable that the minimum for Portland is 6° below that of the Weather Bureau, as given in Table I, and Augusta is 1° below. There is reason to doubt the accuracy of some of these temperature records made by local and untested thermometers, for Oxford and Mechanic Falls are half-way between Lewiston and North Bridgton, in the same latitude, where weather bureau voluntary observers recorded —24°. Again, it seems remarkable that Rockland should drop to —28° when none of the five other coast points from Portland to Eastport registered below —20°. It would seem probable that Rockland was also about —20° F. I have therefore placed the readings made by weather bureau observers after those of Prof. Hitchings in ( ) and those based on the above remarks in the same way with an *.

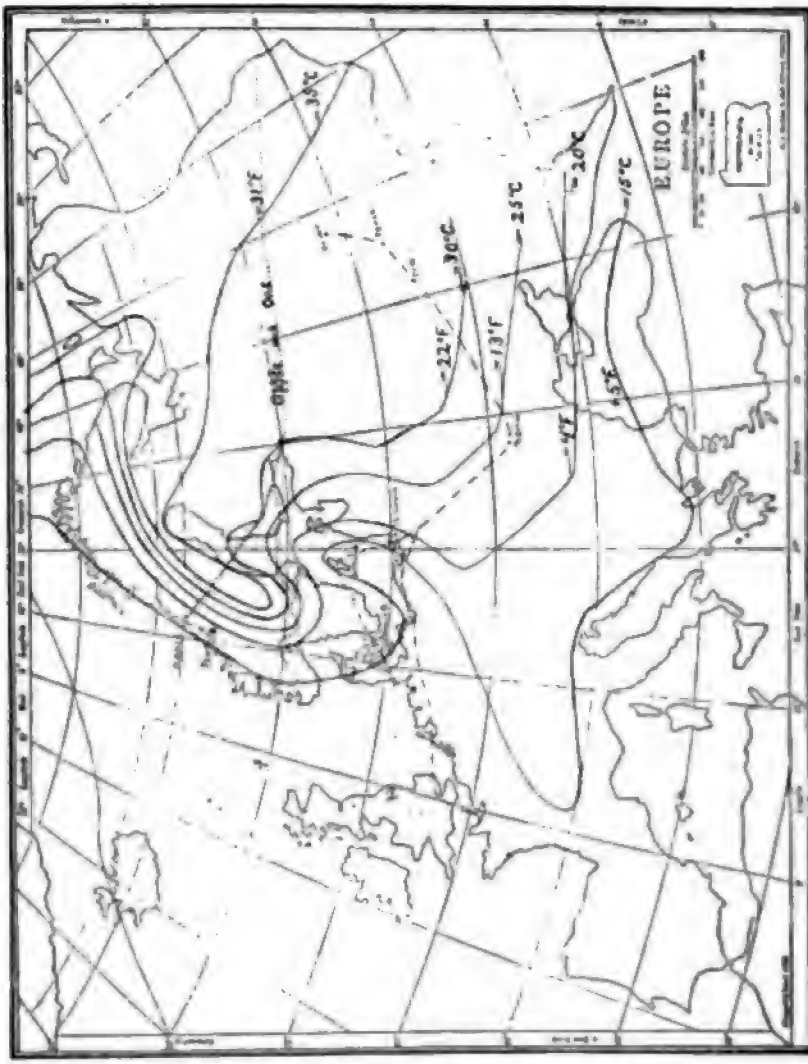
The question at once arose whether the northern spread of this pest might not be limited by such minimum temperatures, for over

Map 1

most of the area to which the moth spread in Maine during 1906 the temperature dropped to —25° to —30°F.

Grevillius[1] has shown that if nests of the brown-tail moth be placed in a freezing mixture giving a temperature of —30°C. (—22°F.) for

Map 2



Map 2. Annual minimum isotherms of Europe. (Copied from Plate 8, Bartholomew's Physical Atlas, Vol. III, by J. W. Van Bibber.) Northern boundaries of the Brown Tail Moth, Oak, Apple, and Pear as given by Grevillius (l.c. text). Compiled by author.

a short time, that most of the larvæ are killed, but that only with a minimum of —35°C. (—31°F.) were all killed in larger nests of

[1]Grevillius, A. Y., Botanischen Centralblatt, Band 18, Zw. Abt., Hefte 2 (1905), p. 305-313.

129 to 359 larvæ. The minimum length of time at —35° C. necessary to kill them does not seem to have been determined. It should also be noted that most of the experiments were made with nests containing but few larvæ compared with those of this country, rarely containing over 100, while here the average is over 300 larvæ, and as has been shown the larger nests better withstand the cold. Grevillius notes that the larvæ in the outer parts of the nests are killed first and that those in the center survive. The size of the nest, therefore, greatly complicates the determination of the minimum temperature for this species.

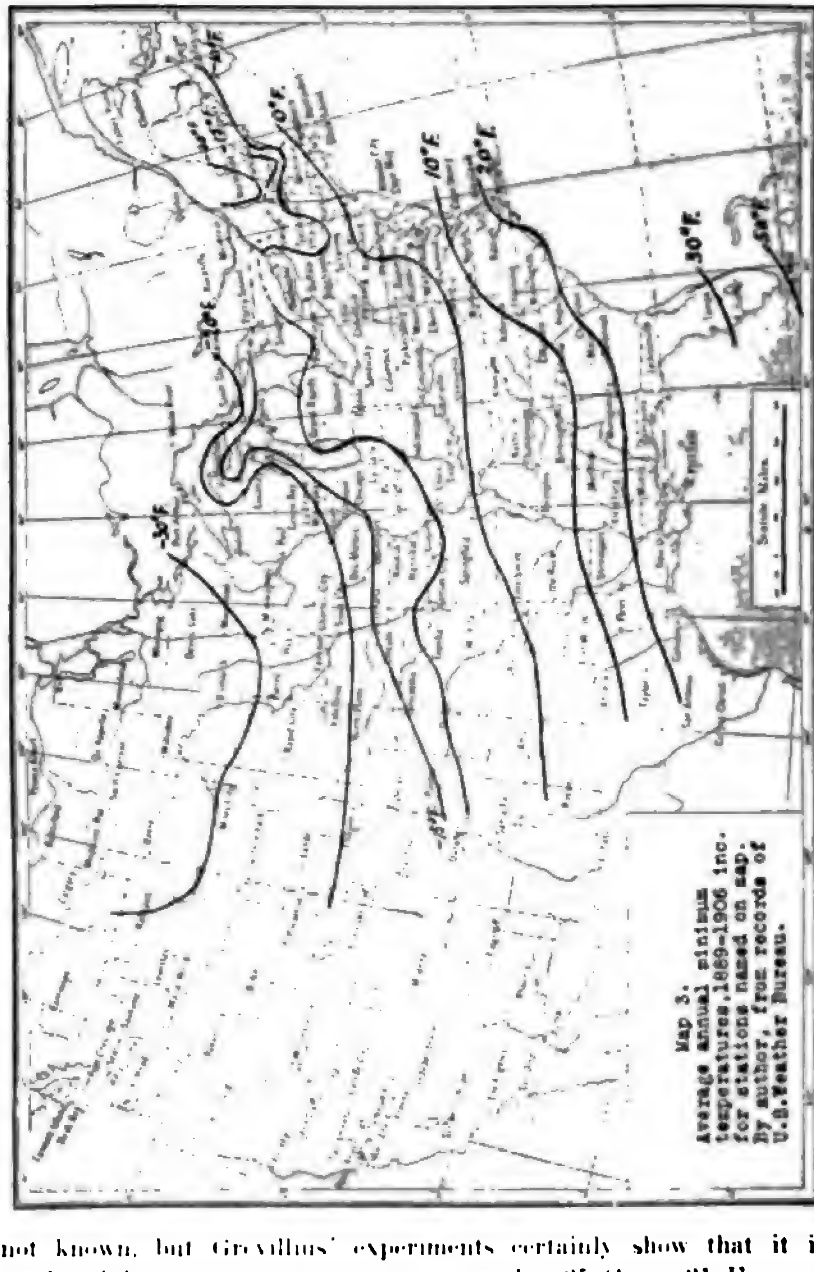
Comparing the northern limit of the brown-tail moth in Europe with the annual minimum temperature occurring there (see map 2), Grevillius remarks (l. c. pg. 314) that Kasan at the northern limit of the brown-tail moth in Russia has a mean annual minimum of —32° or —33°C., and that it is noteworthy that this temperature corresponds with the minimum temperature at which larvæ could exist in his experiments, but that there is a possibility that the larvæ may have adapted themselves to a lower temperature to which they may be exposed for a longer time than in his experiments. The relations of the isotherms of the mean annual minimum temperatures with the northern limits of the brown-tail moth, oak and apple in Europe are certainly suggestive. In northwestern Europe it seems well established that the pest is kept in check by the greater humidity encouraging the growth of fungous disease. The southward curve of the boundary of the brown-tail moth to Podolia follows that of the mean annual minimum isotherms, but its extension northeastward to Kasan cannot be accounted for thus.

From the elaborate researches of Bachmetjew[1] concerning the "critical point,"[2] it would seem that the maintenance of the temperature of the "critical point" for from a few minutes to not over half an hour would result fatally to the insect, and that the time required to produce death at any temperature above the critical point will vary conversely with the difference between it (the body temperature reached) and the critical point. Unfortunately the "critical point" of the body temperature of the brown-tail larvæ in their nests is

[1]Bachmetjew, P., Experimentalle entomologische Studien vom Physikalisch-chemischen Standpunkt. (Leipzig, 1901) p. 80–90, 132–135.

[2]It is unfortunate that Bachmetjew has used the term "critical point" to define the temperature at which the protoplasm commences to freeze, in an entirely different sense from that previously employed by phenologists who designate the temperature above which positive or effective temperatures must be summed as the "critical temperature," as mentioned on pg. 255 of this paper.

Map 3



Map 3.
Average annual minimum temperatures, 1889-1906 inc. for stations named on map. By author, from records of U.S. Weather Bureau.

not known, but Grevillius' experiments certainly show that it is produced by an outer air temperature of −35 C. (−31 F.) and our records from Durham would show that with nests of similar size an air temperature of −24 F. (−31 C.) is fatal.

It would seem evident, therefore, that the larvæ of the brown-tail moth cannot exist in average size nests where the annual minimum averages —32° to —35°C. or —25° to —31°F.

The effect of minimum temperature on insect life has been frequently recorded, but little study has been given its significance, and only few writers have hazarded the suggestion that the northern distribution of insects might be governed by minimum temperatures.

Dr. L. O. Howard is the first writer, known to me, to definitely formulate this principle in America, though he mentions it as exceptional, and cites only one example. Concerning the American Locust (*Schistocerea americana*)[1] he says, "This species is one of the forms which would seem to indicate that in a few cases, at least, the winter temperature must have some effect in determining distribution. It is exceptional from the fact that it hibernates in the adult condition and we can hardly avoid the conclusion that it is limited in its northern range by circumstances which influence successful hibernation. Nothing is better known than that exceptional freezes may kill off thousands of insects; there must therefore be species whose successful hibernation is limited to certain degrees of cold."

Dr. F. H. Chittenden[2] emphasizes this and states that

". . . . in certain forms of insects the winter temperature must have some effect in determining distribution. While admitting that the past winter was exceptional as regards temperature, the writer feels confident in carrying conclusions still farther in stating that in his opinion, based upon the study of the effect of that winter on injurious northern and southern forms of insects occurring in that portion of the Carolinian or humid life areas of the Austroriparian and Alleghanian zones (a climate like that of the District of Columbia), mean winter temperature has more effect upon determining the rarity or abundance of these species than has the mean summer temperature."

To test this hypothesis, the writer has drawn the average annual-minimum isotherms for the regular stations of the U. S. Weather Bureau (see map 3) together with the maximum annual minimum[3] isotherms (see map 4).

Comparing these with the isotherms of the absolute minima (see map 5), it is seen that the absolute minimum is usually about 10° lower, and the maximum annual-minimum 10° higher than average

[1] "Notes on the Geographical Distribution within the U. S. of Certain Insects Injuring Cultivated Crops," Proceedings Entom. Society, Washington, Vol. 3, p. 225.

[2] Insects and the Weather: Observations During the Season of 1899," Bulletin 22, n. s., Division of Entomology, U. S. Dept. Agr., p. 62.

[3] I. e., the highest annual-minimum recorded.

Map 4

Map 4.
Maximum annual minimum temperatures, 1889-1906 inc. for stations named on map. By author, from records of U.S. Weather Bureau.

annual minimum and that the absolute, average and maximum-annual minimum isotherms follow approximately the same paths with the exception of the absolute minimum 20°F. Had the average

annual-minimum and maximum annual-minimum isotherms been drawn from records from all the voluntary observers, the dip in southern New York would have extended farther south and many isolated spots in the Alleghanies would stand out with lower temperatures than here indicated.

Upon comparing these isotherms with the boundaries of the life zones (see map 6), charted by Dr. C. Hart Merriam, many similarities become apparent, but also a number of important differences, and upon comparing the distribution of several well known injurious insects with the average annual-minimum isotherms, they were found to define the northern limits in some instances rather better than the life zones of Doctor Merriam.

The basis for the establishment of these zones has been stated by Doctor Merriam as follows:[1]

"Investigations conducted by the Biological Survey have shown that the *northward distribution of terrestrial animals and plants is governed by the sum of the positive* (or 'effective temperatures,' *i. e.*, over 43° F.—E. D. S.) *temperatures for the entire season of growth and reproduction, and that the southward distribution is governed by the mean temperature of a brief period during the hottest part of the year.*"

Isotherms plotted by Doctor Merriam on this basis were found "to conform in the most gratifying manner with the northern boundaries of the several life zones." In Bulletin 10 (l. c.) the "governing temperatures" of the zones are given and the maps previously published were slightly modified in agreement with this hypothesis, which map does not seem to have been revised in any subsequent publication.

The distribution of many common insects, some of which will be noted below, shows that there are numerous exceptions to the first part of this law, and leads us to question its validity as regards northward distribution. Is the *sum of the positive temperatures for the season of growth and reproduction* the only or most important factor governing distribution northward? At least three fundamental objections to this law being of first importance will be illustrated by the examples below.

First. Many insects which have two or three generations at 35° to 40° N. Lat. might readily reproduce in southern New Hampshire (about 43° N. Lat.) were their existence merely dependent upon a sufficient summation of temperature over 43°F. (6°C.) which do not

[1]Bulletin 10, Division of Biological Survey, U. S. Dept. Agr. (1898), p. 54.

Map 8

Map
Absolute minimum isotherms.
Copied by author from Plate XIV,
Bulletin Q, U.S. Weather Bureau.

occur north of Long Island N. Y., southern Connecticut and Rhode Island in appreciable numbers. Other species which might have one generation and exist in abundance if merely so limited occur but

sparingly in southern New Hampshire, if at all. That the "sum of effective temperatures" is an important factor is not disputed, but evidence accumulates that the "critical point" (in the sense of phenology) from which the "thermal constant" should be computed varies with groups and species of animals and plants. For example, melons and egg-plants are grown in eastern Massachusetts, but cannot be matured successfully at Durham, N. H. They are planted in Massachusetts about May 20 to 25 and in New Hampshire about June 1, and mature in Massachusetts about September 1. The effective temperature over 43°F. for Boston for the three months is 2343°F. and for Durham, N. H., 2061°F. The effective temperature in May and September is of no value in this connection. That these plants cannot be grown in New Hampshire is due to the fact that there is not sufficient "effective temperature" over 60°F., which is the temperature above which these plants must be grown, or their "critical point." Boston has 801°F. over 60° in summer, while Durham, N. H., has only 525°, or lacks 35% of the requisite effective temperature. Other examples will be given below.

Second. But even if the "effective temperatures" be accumulated above the true "critical points" instead of over 43°F., still there are numerous cases in which there is a sufficient positive temperature for the development of species in southern New Hampshire which are not known to breed there or in eastern Massachusetts commonly. Some other law must therefore determine the limitation of these species to a more southern clime.

Third. It is well known that the main question in the introduction of horticultural varieties northward is one of "hardiness." Many varieties will fruit and mature at latitudes where they cannot grow on account of lack of hardiness. Probably as large a number are disqualified for northern growth on this account as by the shortness of the season.

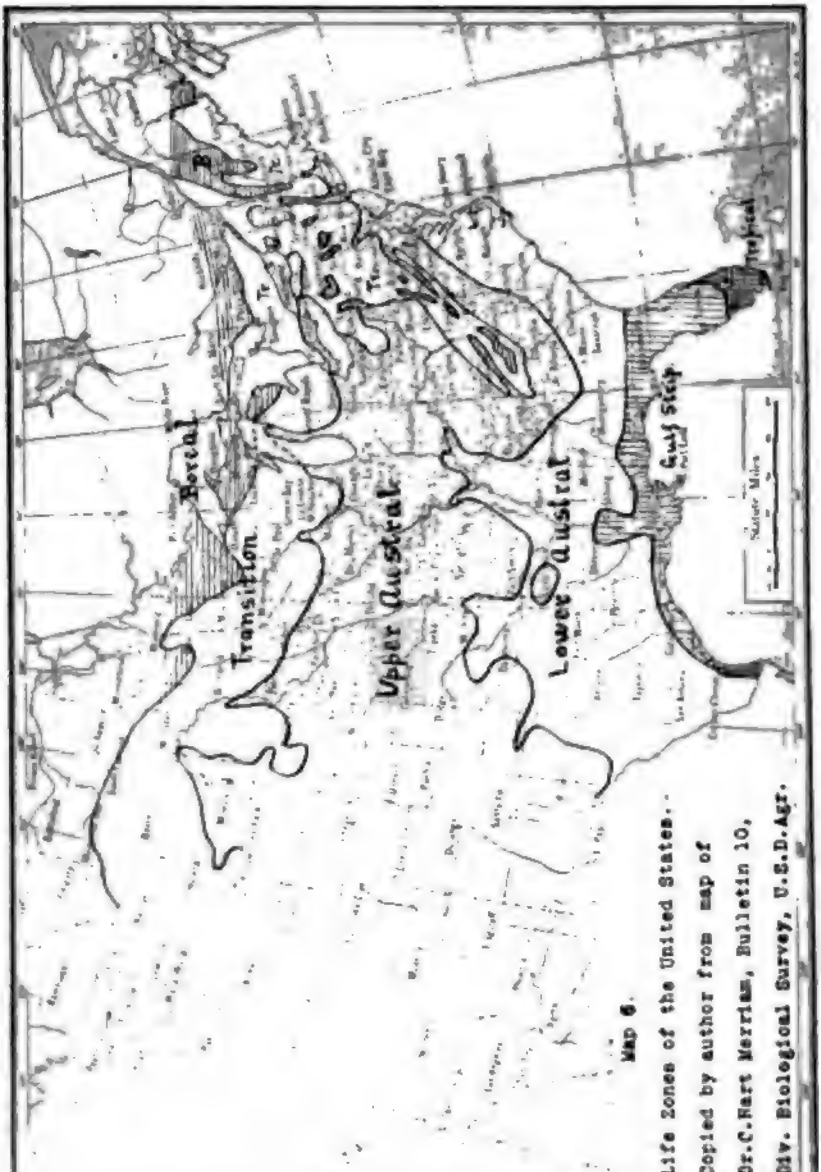
If the southern spread of some species is controlled by the heat of summer, which is undoubtedly the case, why should not the direct opposite be true, and why may not the northward spread be controlled by the cold of winter?

The following species have been studied with reference to these objections and as to whether the influence of minimum temperatures offers any explanation of their northern limits.

The Harlequin Cabbage Bug (*Murgantia histrionica*) has migrated from Mexico around the Atlantic coast to Long Island, N. Y., and up the Mississippi Valley to southern Ohio, where it occurred in five counties bordering the Ohio River in 1895.[1] In 1899 the temper-

[1]Bulletin 68, Ohio Agricultural Experiment Station, p. 36 (1896).

Map 6



atures at Cincinnati dropped to 17° F. and in these counties to about 20° F. As a result, Prof. F. M. Webster stated that the insect had "certainly sustained a severe repulse by the low temperature *of last winter*." While observed breeding in Clermont County, south-

ern Ohio, last May, its almost entire absence has been reported in localities where last year it was disastrously abundant."[1] Later Professor Webster stated[2] that it "had spread at one time as far north as Chicago, Ill., and had almost reached the shore of Lake Erie in Ohio. A very severe winter, however, had killed it off in southern Illinois and Ohio, and it has not recovered this lost ground, and might not again in years." It probably still occurs in extreme southern Ohio according to Prof. H. A. Gossard and was noted by Professor Webster in 1901. Doctor Chittenden[3] noted its scarcity in Washington, D. C., in 1899, following a minimum of —15°F., and the writer made the same observation in Delaware. This was the lowest temperature which had been experienced at Washington for over twenty years. As it was accompanied by heavy snow, the harlequin bug was largely protected from the severest cold, otherwise it would doubtless have been exterminated.

The harlequin bug emerges from hibernation at Newark, Del., about May 1, when the temperature is about 55°F. In midsummer, at 74°F., the life cycle there occupies about one month. The life cycle thus consumes 1236°F. over 43°F. At Durham, N. H., there is 2925°F. over 43° from the middle of May to the middle of September, during which time the mean is over 55°F., and according to Merriam's law the species might exist there with two generations. But even if we take 55° as the critical point, there is required but 726° for a life cycle in Delaware and there is available 1119° at Durham, N. H., enough for one brood. But the harlequin bug does not occur north of Long Island, N. Y., and is not spreading there. The northern limit of this species follows the average annual-minimum isotherm of 0°F. (map 2) much more closely than the Upper Austral Zone. It may yet migrate to northern Ohio and Ontario, but further progress seems doubtful.

The Cotton Boll Worm or Corn Ear Worm (*Heliothis obsoleta* Fab.) is injurious throughout the upper and lower Austral zones, but only exceptionally in the transition. It has been injurious at London, Ont., near Boston, Mass., in 1894, and rarely in Michigan. It does not winter in Minnesota and no records of injury occur in Dakota, Montana or Wyoming.[4] Professor Quaintance remarks, "The severe character of the winters of the more northern states coupled with the relatively low sum of effective temperatures, no doubt has

[1] Bulletin 20, Bureau of Entomology, U. S. Dept. Agr., p. 72 (1899).
[2] Bulletin 60, Bureau of Entomology, U. S. Dept. Agr., p. 130 (1906).
[3] Bulletin 22, n. s., Division of Entomology, U. S. Dept. Agr., p. 55.
[4] Bulletin 50, Bureau of Entomology, U. S. Dept. Agr., p. 26–27.

an important bearing on the comparative immunity of this territory from serious injury." Doctor Chittenden reported the species rare on corn at Washington, D. C., in 1899 following —15°F. in February, where it is usually very abundant.

Eggs of *H. obsoleta* were laid at Newark, Del., about June 12, 1900, and moths from them emerged July 15, at a mean temperature of about 73°F., thus requiring approximately 900° above 43°F. Quaintance (l. c.) found the average effective temperature in Texas to be 1417°F. He also shows (l. c. p. 86) that the sum of the effective temperatures for pupal development are more nearly equal for different temperatures when computed above 58° or 60° than above 43°F. He also shows that at Boston, Mass., there could be two generations with a total effective temperature of 2967°F. over 43°, commencing when the monthly mean has reached 62°F., or May 1. Further, if 58°F. were taken as the critical point, there would have been required in 1900 only 450° at Newark, Del., while there were 801° at Boston and 525° at Durham, N. H. Yet the species breeds only rarely in eastern Massachusetts, according to Dr. H. T. Fernald, and is practically unknown at Durham. The summer temperature evidently does not control the northern limit in this case, though the distribution of the species is practically that of the Austral zones. May not the minimum temperature be the controlling factor?

Prof. F. M. Webster records[1] that the West Indian Peach Scale (*Aulacaspis pentagona* Targ.) withstood —9° during 1897-'98 sufficiently to increase in numbers the next season at Wooster, Ohio, but that in 1899 the temperature fell to —21° one night and to —12° to —18°F. in several successive nights, with the result that all of the scales succumbed.

Mr. C. L. Marlatt[2] calls attention to the influence of the minimum of 1899 (—15°F.) at Washington, D. C., on scale insects, 95 to 100%, of such species as *Diaspis pentagona*, *D. rosae*, *Aspidiotus perniciosus*, and others being killed. He points out that such mortality is more likely to occur at Washington where the hibernation of these scales is short and where low temperatures are rarer than further north.[3]

At Nashua and Manchester, N. H., during the past winter something over 60 per cent of the scales were killed by —13°F., but are breeding abundantly now

The northern limit of the San Jose Scale is shown on map 7. The

[1]Canadian Entomologist, XXXI, p. 120 (1899).

[2]Bulletin 20, n. s., Divison Entomology, U. S. Dept. Agr., p. 76.

[3]See also Voyle, Bulletin 4, old ser., Div. Entomology, U. S. Dept. Agr., p. 70-75. "Low Temperatures vs. Scale Insects."

Map 7

hope, as expressed by Dr. L. O. Howard,[1] that this species would be limited to the upper Austral has not been realized, though the excep-

[1]Proc. Wash. Ent. Soc. III, p. 222 (1895).

tions occur only in Michigan, Massachusetts, New Hampshire and southwestern New York. The average-annual-minimum isotherm of —15°F. corresponds much more closely with the northern limit of this species than the upper Austral as given, with the exception of northern Michigan and Ontario, but approaches the limit of the scale much better in Iowa and Nebraska, which are wholly within the upper Austral, but where the scale is practically unknown. The annual-minimum temperature of its native home in China is about 5°F., according to Bartholomew's Physical Atlas, Vol. III, Meteorology, Plate II.

Based upon the data given by Marlatt[1] concerning the life history of the scale, there can be two generations in southern New Hampshire, with an effective temperature of 1570°F. over 53°F., a single brood requiring 600°F. over 53°F. at Washington, D. C., and reproduction commencing at both points when the mean is about 63° F.,—at Washington May 15, at Nashua, N. H., about June 15. Two generations occur in southern New Hampshire according to our observations.

The Asparagus Beetle (*Crioceris asparagi*) was first imported near New York City. It occurs in southern New Hampshire, but is very rarely injurious, often dying out for several years. Chittenden records that it was introduced and completely died out at Rock Island, Ill., many years ago. Its northern limit agrees quite closely with the average-annual-minimum isotherm of about —10 F. (see map 3). It occurs in southwestern New York and northeastern Ohio in the transition. Doctor Chittenden[2] quotes C. W. Prescott of Concord, Mass., as stating that "immense numbers are killed in winter during severely cold spells following open weather" and states that the beetles are quite susceptible to low temperatures. Indeed Doctor Chittenden[3] definitely attributes the limitation of the northward spread of this insect to "cold snaps." At Washington, D. C., the beetles emerge from hibernation in April with a mean of about 55 F. The life cycle from egg to adult occupies three weeks, or an effective temperature of 420 F. over 55, or 300 over 60 F. at Washington, yet it is not common at Durham, N. H., though 1119 over 55 and 525°F. over 60 F. are available.

The distribution and data concerning the life history of the Elm Leaf Beetle (*Galerucella luteola* Müll.) practically duplicate that given for the asparagus beetle and do not need to be enumerated here.

[1]Bulletin 62, Bureau of Entomology.

[2]Yearbook U. S. Dept. of Agr. 1896, p. 347.

[3]Bulletin 22, p. 63, note.

In its northern spread the Cotton Boll Weevil (*Anthonomus grandis* Boh.) had reached the northern boundary of Texas at the end of 1904. In February, 1905, the temperature dropped to 1°F. at Dallas and 14°F. at College Station, Texas. As a result, I am informed by Prof. A. F. Conradi that it seemed to have been killed out entirely north of Dallas and the spread of the previous season was offset, while as far south as College Station so few hibernated successfully that but comparatively little damage was done the following season. The advance of the weevil was also given a decided set-back in Louisiana the same winter, though only in the northern part can this be attributed to low temperature. Again in June, 1906, the agents of the Bureau of Entomology were unable to find weevils which had hibernated successfully in Dallas, Ellis and Navarro counties, Texas, which had been infested for three or four years, following a minimum of 12°F.[1]

It is also interesting to note that from the first, the boll weevil and other southwestern insects have spread much faster eastward than northward.[2]

About 1903 the Morellos Orange Fruit Worm (*Anastrepha ludens* Loew) was introduced from Mexico and became established near Brownsville, Texas. Prof. A. F. Conradi, state entomologist of Texas, advises the writer that it had become quite abundant in this region, but since the freeze of February, 1905, when a minimum of 22°F. occurred, he has been unable to find any evidence of the pest.

It is probable that the absolute minimum temperature is not the controlling factor in limiting the northward spread of insects, for many individuals would always survive in sheltered situations, and these absolute minima occur at very long intervals. But it would seem evident that where the average-annual-minimum temperature is below that at which a species can exist, that it will never become abundant. Inasmuch as the extreme cold of winter is usually in spells of short duration, the average-annual-minimum temperature of any locality is probably a better index of the effect of winter temperature there than the average mean temperature, average daily minimum, etc. Were thermograph records available for the different stations, a summation of the temperatures below a certain point might possibly be more accurate, for it must be remembered that, as Bachmetjew has shown, an insect may be killed by more protracted cold at

[1] For further discussion see a forthcoming bulletin of the Bureau of Entomology, "Some Factors in the Natural Control of the Mexican Cotton Boll Weevil."

[2] Webster, *et al*, Bulletin 60, Bureau of Entomology, p. 130.

a temperature considerably above its "critical point," or absolute minimum.

Snowfall will exercise an important influence in limiting the effect of minimum temperatures. Thus the present season the Rose Chafer (*Macrodactylus subspinosus*), whose larva winters in the soil, has been exceptionally abundant, and the Striped Cucumber Beetle (*Diabrotica vitatta*), which hibernates in the earth, has been as injurious as usual, in spite of the low temperatures of last winter, both having been protected by the deep snow blanket. Species hibernating above ground will therefore be most susceptible to minimum temperatures. Humidity will also materially affect the influence of minimum temperatures.

From the above discussion it seems that the following conclusions may safely be drawn:—First, that the present Upper Austral Zone of Doctor Merriam does not extend far enough to the northeast and extends too far to the northwest. Second, that there is strong evidence against the effective temperature of the growing season being the only or controlling factor in determining the northern limits of life areas. Third, that minimum temperatures often limit northern distribution. Indeed, is it not probable that the laws governing the distribution of life are a complex resulting from many different causes which are of variable importance with each species? Though hypotheses concerning the general principles involved are of the greatest value in forming a basis for further investigation, yet the true life zones can only be ascertained by a patient accumulation of data concerning the actual distribution and spread of life as found, when a comparison with the known physiographical and meteorological conditions will make apparent the laws underlying the distribution of life.

TWO INTERESTING INQUILINES OCCURRING IN THE NESTS OF THE ARGENTINE ANT

WILMON NEWELL, *Baton Rouge, La.*

In the February issue of the JOURNAL quite lengthy mention was made of the habits of the Argentine ant, *Iridomyrmex humilis* Mayr, which has become a pest of serious nature in the southern parts of Louisiana and Mississippi.

Although the writer has had this species under constant observation for the past ten months, not a single parasitic or predaceous enemy of it has been discovered. The insects which dwell with this ant, in its colonies, are very scarce and none of the true insects are as yet posi-

tively known to be persistent guests or constant dwellers in the colonies of this species. Certain *Staphylinidæ* are found in decaying logs and in rubbish heaps which are literally honeycombed with the galleries of the Argentine ant, yet these beetles, when confined in the artificial formicaries with populous colonies of this ant, fail to survive. In fact, when placed in a formicary they are invariably attacked by the worker ants. Whether this is due to the unnatural conditions surrounding the ants is a question, as the ants live, thrive and increase in the artificial formicaries with apparently the same freedom and facility as in the purely natural outdoor colonies.

The first and only true guests as yet observed in the colonies of the Argentine ant were found by the writer in March of the present year. Upon examining a large colony located in a heap of decaying cotton seed and straw, thousands of brown mites were found and while the first impression was that they were breeding in the decaying vegetation, examination of the entire heap showed that the mites occurred only in the heart of the ant colony.

Specimens of these mites were sent to Dr. L. O. Howard, who submitted them to Mr. Nathan Banks of the Bureau of Entomology. Mr. Banks found that there were two distinct species, both new, and he kindly prepared descriptions of them as follows:

Uropoda agitans n. sp.

"Body oval, in the female slightly more pointed behind than in the male; about one and one half times as long as broad, broadest behind coxæ III and IV; the anterior tip of the body frequently depressed a little so as to appear slightly emarginate in front. Dorsum smooth, two little bristles in front under anterior margin; venter with a few short, stiff bristles, a pair slightly in front of the anus and a pair more widely separate behind. Peritreme very large at stigma, a slight projection beyond, anterior part at first curved, then extending obliquely forward and outward, then suddenly turned upon itself it runs back and diverges toward coxa II. Female genital aperture large, occupying all the area between coxæ and reaching to the camerostome, and behind to middle of coxa IV; the male genital aperture is only a little longer than broad, and about its length from the camerostome. Legs short, I with many hairs near tip, one as long as tarsus, other legs with short spines, most numerous on the tarsi. Hind tarsi about as long as space between hind coxæ. Length 9 mm.

"Baton Rouge, La.; associated with the Argentine ant."

Uropoda provocans n. sp.

"Body elongate oval; tip more acute, anterior end slightly produced in the middle. Dorsum with many prominent bristles; the two bristles under anterior margin are very long, two thirds as long as tarsus I; venter with a number of bristles. Peritreme large, with a very small inner prolongation, anteriorly it runs nearly straight at first, then curves outward and turns

on itself and runs toward coxa II. Female genital aperture not quite reaching the camerostome, and behind hardly extending to coxa IV. Male genital aperture one and one-fourth times longer than broad, and still farther from the camerostome. Legs of moderate length; the tarsi quite slender, I with many bristles near tip, one of them as long as the tarsus, other tarsi with short spines, the hind tarsus fully as long as space between hind coxæ. Length 1. mm.

"Baton Rouge, La.; associated with the Argentine ant."

For the purpose of determining the habits of these mites and the part played by them in the economy of the ant colonies, several hundred were placed in a colony of the Argentine ants, confined in a modified Janet cage, cast of plaster of Paris and containing five chambers, four of which connect with each other by means of small tunnels, the fifth chamber being for the reception of water to maintain humidity in the nest. In a cage of this character one chamber, usually the one furthest from the entrance, is invariably "set aside" by the ants as a cemetery, in which all dead individuals, refuse matter from the nest, etc., is deposited from time to time. It has been our custom to leave the chamber nearest the entrance covered only with glass, to form a sort of "vestibule" to the nest proper.

Fine trash, containing eggs, larvæ and pupæ of the Argentine ant as well as hundreds of the two species of mite were placed in the vestibule of one of these cages on March 11th. The workers immediately selected all ant larvæ, eggs, and pupæ from the trash and carried them into the nest proper, paying no attention to the Uropodas and neither attempted to destroy them nor carry them into the nest. The vestibule, or outer chamber, was by far the dryest compartment and during the two following days the Uropodas which failed to find their way through the small tunnel into the nest proper perished, either of starvation or lack of moisture. On the third day following their introduction, some of the living mites were in the nest with the workers and young, but the great majority had found their way through the two living chambers and three tunnels to the back chamber or "cemetery," where they were feeding upon the refuse matter placed there by the ants. Since that date, a period of about 100 days, the mites have continued to thrive in this colony. The mites never attack the immature stages of the ant nor do they seem to cause any annoyance or inconvenience to the latter. The ants, for their part, seem to be entirely indifferent as to the welfare of the mites. They never attempt to remove them or care for them, but appear to regard them with a spirit of kindly toleration. Observations made upon these mites in other colonies but served to verify these conclusions. In the case of one Janet cage the solvent action of the water, which

was added from time to time to preserve the requisite amount of moisture within the cage, resulted in small cavities being formed outside the nest. From time to time a mite would find its way into one of these cavities and would remain there for a longer or shorter time. Such mites were constantly watched over by a detail of from two to six workers from the colony and while the workers never fed or in any other manner cared for the mites, so far as could be determined, they were nevertheless unremitting in their self-imposed guardianship both day and night.

That the mites were in no way dependent upon the ants for food or for care was determined by placing several hundred of the former in a plain glass bottle with a small supply of worker and larva "cadavers" and other refuse matter taken from the cemeterial chamber of a large artificial formicary. Water was added from time to time to keep the mass sufficiently moist and the bottle isolated by water to prevent any living ants from obtaining access to it. On this dead and decaying matter the mites lived and thrived for over sixty days, when other duties caused us to neglect the daily application of moisture and the death of the mites resulted.

We therefore feel safe in venturing the opinion that these two mites are scavengers, pure and simple, in the colonies of the Argentine ant and as such they are tolerated by the latter, although their presence is not necessary to the welfare of the community and no effort is made by the ants to secure or retain their services.

Careful search in the colonies of other species of *Formicina* has thus far failed to reveal the presence of either of these two species of *Uropoda*.

Baton Rouge, La., June 22, 1908.

THE FUNDAMENTAL PRINCIPLES OF SPRAYING

By H. T. Fernald, *Amherst, Mass.*

The use of arsenical poisons in the control of insect pests has now continued for nearly half a century. During that period, starting with but a few pounds a year, the demand has increased until many tons of these materials are now annually consumed and their use is one of the fundamental principles of economic entomology. Yet, a careful examination of our actual knowledge of arsenicals in their relation to insect and plant life gives surprising results, showing how little is really known and how much is merely empirical, and in-

dicates that a broad field for chemical, entomological and physiological research is waiting for explorers.

Everyone who sprays is aware how variable are the results he obtains at different times; how one treatment may be very successful while another, under apparently similar conditions, may prove much less satisfactory. Some writers advise spraying on warm, cloudy days; others on bright days to obtain the best results. The addition of one or two pounds of lime to each pound of Paris Green to prevent burning the foliage is generally urged; yet, even then, injury sometimes follows, and the only explanation generally offered seems to be that the materials were not sufficiently well mixed.

It is generally claimed that injury to foliage is due to the presence of free (uncombined) arsenic in the spray, but it is interesting to note that even this has not been conclusively proven. And when the nature of the action of the poison on the insect is questioned, the answer seems to have been drawn entirely from human toxicology rather than from a study of the poisoned insects themselves, while differences in the ease with which different pests are killed by poisons have been explained as due to varying powers of elimination of the poisons from their bodies,—only a guess, though one which may prove to be correct.

Even the chemical aspect of the insecticides has its uncertainties. Dictionaries of solubility state that copper arsenite is insoluble in water, whereas everyone who has used this substance as a spray knows that it is necessary to add lime to prevent burning the foliage. It would seem then, either that such statements as to solubility are very loose in their nature, or that the burning is due to some of the impurities always present in commercial articles. Which is the truth? What are the impurities and what parts may they play when used as sprays? These and many other questions must be settled by the chemist and entomologist working together.

Weather conditions have already been mentioned. How far do these affect or modify results when other factors remain fixed? Is it sunlight, temperature, humidity or all these and perhaps other conditions in addition which are involved? The meteorologist must also contribute his share toward the solution of spraying problems.

At the present time there are too few data of experiments made under conditions known with exactness; with materials of fixed and known composition; and with careful studies of the results, to enable us to draw safe conclusions on this subject. Many factors are involved and these must each be studied separately in their changes while the others remain fixed, thus involving long series of experi-

ments, before we shall have a knowledge of the fundamental principles which will enable us to attain the best results. Such an investigation has already been begun at the Massachusetts Experiment Station with the anticipation that five or ten year's work may give results which will help place spraying on a firm and scientific basis.

DESCRIPTION OF NEW DEVICES FOR REARING INSECTS

By A. F. Burgess, *Washington, D. C.*

One of the serious problems which it was necessary to solve in order to successfully rear the parasitic and predaceous insects which were being shipped from Europe to prey on the gypsy and brown-tail moths was to secure apparatus by means of which these insects, as well as their hosts, could be successfully reared in large numbers. All of the old style equipment in general use by entomologists for rearing work was tested, but in many cases it was found that radical improvements were necessary in order to accomplish the results desired. It was of primary importance to place the insects under as nearly as possible natural conditions and at the same time to keep them in confinement where they could be studied and observed and not allowed to escape from captivity. The purpose of this paper is to call the attention of working entomologists and others who may be interested in rearing insects to several devices which are now in use at the Gypsy Moth Parasite Laboratory, Melrose Highlands, Mass., and which have been found to meet some of the serious defects of the equipment that is in general use in insectaries and insect-breeding laboratories.

The most important of these is a tray for rearing insects which was devised by Mr. W. F. Fiske of the Bureau of Entomology, Washington, D. C., who is in charge of the Parasite Laboratory. It is illustrated in Pl. 3, Figs. 1 and 2. The standard size used at the laboratory is 14 in. square and 3 in. high. The bottom is covered with cheese-cloth which is attached by paste to the sides of the tray. With the exception of a 2-in. rim around the upper edge, the top is open; while directly beneath this rim a band of sticky Tanglefoot is placed in order to prevent the escape of the insects. This band is applied before the cheese-cloth bottom is attached and it is a simple matter to replace the bottom with a new piece of cheese-cloth when desired. The tray is built of one half inch white wood stock and the joints are securely nailed and glued in order to make it tight. A modification

of this tray has been used with excellent results for rearing larvæ in large numbers. This form is 5 feet long, 2 feet wide, and 4 inches high. Approximately 300 trays of these two sizes have been in use this season and the results have been entirely satisfactory. The advantages of this device over the ordinary Riley cage are very pronounced. Any one who has used the latter for rearing large quantities of larvæ has been confronted with the difficult problem of feeding the caterpillars without allowing them to escape. It is impossible in one of these cages to secure reliable data on feeding habits of the insects, which are being reared, and information concerning the habits of their parasitic enemies cannot be readily obtained because of the small area contained in the cage and also on account of the inability of an observer to watch the oviposition of parasites on their larval hosts. The Fiske tray overcomes practically all of these difficulties. The caterpillars are made to feed in such a way that they are exposed to the view of the observer, the Tanglefoot band preventing them from escaping from the tray. In case it is desired to make observations on the oviposition or habits of parasitic insects which attack the caterpillars, these trays can be placed in a tightly screened room or house in which the parasites may be liberated and where the observer can have ample opportunity to observe their operations.

For the purpose of rearing some insects, such as beetles which spend a part of their life in the ground, it is usually desirable to use glass jars partially filled with earth. We have in the past used cheesecloth covers, which were held in place by rubber bands or string. Both of these methods of fastening are objectionable, the former on account of the continual breaking of the bands and the latter because of the annoyance in untying the string to remove the cover. Some insects are able to cut through the cheesecloth and make their escape and this has often caused the loss of specimens from which valuable data was being secured. This year we have used a circular, wooden cover made of one inch planed pine. (See Pl. 4, Fig. 3.) A groove was turned one half inch from the outer edge of the cover and of sufficient width to admit the upper edge of the jar. A 2-inch hole was then cut or bored in the center, the under side of which was covered with wire mosquito netting. This furnishes a cover which can be easily removed and replaced and is tight enough to prevent the escape of insects which are being reared. The wire netting in the top furnishes sufficient air supply to prevent condensation of moisture on the inside of the jar.

Another cage which has been successfully used this season for rearing Calosoma larvæ is illustrated in Pl. 4, Fig. 4. It is 10 inches in

Fig. 1.

Fig. 2.

FISKE TRAY: Fig. 1.—Top view of Fiske breeding tray. Fig. 2.—Bottom view of same before cheesecloth bottom is put on. *A* indicates where the cloth will be placed on the bottom. It must be large enough to lap over and be pasted on the sides. *X* indicates where the band of Tanglefoot should be applied.

BEETLE CAGES: Fig. 3.—No. 1, jar with wooden top. No. 2, jar with cheesecloth top held in place with rubber band. No. 3, construction of under-side of wooden top. Fig. 4.—Illustrates construction of wire cage for rearing insects in the ground. The side figures show the top and bottom of the cage, while the middle figure shows the completed cage, which can be sunk in the ground to the distance desired.

height, 4 inches in diameter, the sides are made of wire mosquito netting drawn into the form of a cylinder and laced with copper wire. The top is similar to the one already described which is used on the glass jars; while the bottom is made in the same way but without the groove. The lower edge of the wire is tacked securely to the wooden surface. In making these cages netting, 20 inches wide, was used, the finished edge always being placed at the top. These cages were sunk about 8 inches into the ground and furnish conditions which are as near natural as we have been able to devise for rearing insects of this class.

A larger cage for hibernating Calosoma adults has been used in our breeding experiments. It is made of galvanized iron wire, 2 feet in width and with a three eighths inch mesh. A strip was cut and rolled into a cylinder, the diameter of which was 5 inches; the overlapping edges were laced with copper wire and the top and bottom, which were made of wire mosquito netting, were sewed on with wire. The cage was sunk 20 inches in the ground and furnished excellent conditions for hibernating these insects.

It is perfectly true that breeding devices must be used which are especially adapted to the habits and character of the insects to be studied, and it may be desirable to modify these cages in such a way as to suit the special needs of the investigator. For the lines of work which we are attempting, the results secured have been very satisfactory and it is hoped that these devices may be of assistance to others engaged in like work.

REPORT OF THE COMMITTEE APPOINTED TO ATTEND THE ANNUAL MEETING OF THE AMERICAN ASSOCIATION OF NURSERYMEN

At the last annual meeting of this association, a committee was appointed, consisting of Doctor S. A. Forbes, Prof. T. B. Symons and Mr. A. F. Burgess, to attend the annual meeting of the American Association of Nurserymen at Milwaukee, Wisconsin, June 10, 11, 12, 1908, for the purpose of conferring with the members of that association relative to matters pertaining to nursery inspection and also in regard to the proposed national inspection and quarantine legislation. Doctor Forbes was unable to be present and the committee was represented by the other members.

At the session held on Wednesday morning, June 10, the following report was submitted by Mr. Orlando Harrison of Berlin, Maryland,

who was the Nurserymen's representative and joint committee on national inspection and legislation:

Mr. President and Members of the American Association of Nurserymen:

The subject of a national inspection law is one that should receive the attention of every nurseryman. It has been said that a poor law is better than none, and I think we all agree that it is better to have a law enforcing inspection for the benefit of all the fruit-growers, entomologists and the nurserymen.

The question now is "Do you want two laws?" One operated by the state and the other operated by the government from Washington, like the Pure Food and Seed laws, as they are now enforced.

Who is to be supreme, the state or the government, in enforcing them?

At a recent conference of the governors of the various states at Washington, D. C., it was made clear that the states, so far as their governors were concerned, are scrupulously opposed to relinquishing to the federal government any of the powers reserved to them under the constitution. Practically every governor present went on record in favor of the states exercising their power to the fullest degree, but in doing this, they also made it clear that they, likewise, favored the exercise by the federal government in the fullest sense of all the powers delegated to it by the states through the constitution. The concensus of opinion seems to be that the states must do their work, the nation its work.

When Federal Power Should Prevail

President Roosevelt has gone on record as recognizing the rights of the states and says in matters that relate only to the people within the state, the state is to be sovereign and it should have the power to act. If the matter is such that the state itself cannot act, then he pleads on behalf of all the states that the national government should act.

Each Must Exercise Its Power

William Jennings Bryan says he is jealous of any encroachment upon the rights of the state, believing that the states are indestructible as the Union is indissoluble, and it is just as imperative that the general government shall discharge the duties delegated to it as it is that the states should exercise the powers reserved to them. He further says, "Nothing that is necessary is impossible."

State Rights

Without state rights we would have no government. Eliminate state rights and you have nothing.

Advantage of a National Law

One thing that could be gained in a national law is to outline a standard law and ask all the states to amend their laws to conform to that as far as practicable. We must remember that the United States government has no power except that given it by the states.

Now it must be taken for granted that the American Nurserymen thought it necessary that something should be done or this committee would not have

been named. I have diligently tried to work out some plan whereby we could all work under one law and all the states share alike.

State Laws Will Remain in Force

If we have a national law, it is quite evident that the state laws will remain in force, but it is possible that the secretary of agriculture conduct the inspection of nurseries through the present state officials, thus allowing only one inspection of our nurseries, which is desirable; on the other hand, it is not desirable that we have two inspections by separate parties.

A Meeting of the Committee

I attended the meeting of the American Association of Horticultural Inspectors and Economic Entomologists held in Chicago December 27 and 28, 1907. Before going to the meeting I sent out eighty-eight letters to the largest growers of nursery stock in the association and received sixty replies, the majority of which favored a national law.

You are all familiar with the resolutions passed by the inspectors and entomologists, which have been published by the trade papers.

[See pages 3–4 and 222–23 of the February and June issues of the JOURNAL for copies of these resolutions. ED.]

The Nurseryman's Side

I said, "The nurserymen are anxious to coöperate with you in combating, controlling and stamping out, if possible, the insect pests and diseases which are liable to be found in the nursery. We realize that it is our duty to our customers and to the man in authority who issues the certificate that they be placed in the proper light with each other and with the grower in issuing the certificate from one state to another. Yet it does seem to us that more stress should be laid by the inspectors upon neglected orchards near a nursery."

Entomologists

I wish it clearly understood after being with the horticultural inspectors and economic entomologists twice at different meetings, I find they are a class of high grade men and are endeavoring to the best of their ability to bring about uniformity in their inspection work. They have their troubles as well as the nurserymen and are trying to solve the problem now before us.

On my return from Chicago, I found several letters from influential nurserymen denouncing most emphatically that any action should be taken without further consideration and presenting the whole matter before the nurserymen at this meeting. I consulted several leading nurserymen and their advice was that every member of the association should be heard.

On May 12 I sent out four hundred and sixty letters and have received replies from two hundred and twenty-five, of which one hundred and seventy have asked for a national or uniform law; twelve against and five neutral.

Of the entomologists or inspectors, thirty-one are favorable and two are opposed.

While many want a uniform law, they want only one law and some do not want a national law. But few who ask for a national law offer any suggestions.

I will give you a few hints from some of the letters received.

From Nurserymen Who Favor

"I have for years thought that there ought to be inspectors at every port of entry to the United States. Of course they could not carefully inspect the contents of every case unless there were strong suspicions, but think they could do a great deal to awaken people elsewhere.

"Then I believe there should be other inspectors to inspect the stock at the nurseryman's place before it is distributed all over the country. Just think what a benefit it would have been to the country if there had been such an inspector in California before the scale was carried all over the country."

Another says: "I favor a national uniform inspection law. I think the gains would be impartiality and uniformity of inspection. This, I think, would soon bring about a modification of the practices in different states, rendering it easier and safer to do interstate nursery business."

Another writes: "I favor a national law because this will place all nurserymen upon an equal basis and do away with the endless delays and troubles on account of the various state laws."

Against a National Inspection Law

Another says: "If national inspection is desired it should include not only nurseries, but orchards, and compel all to keep clear of all kinds of pests."

Another says: "We favor a law that would be equally as stringent upon the fruit grower as well as the nurserymen and all others who own trees of any kind."

Another says: "The writer has recently had a hearing in Washington in regard to a proposed seed law and is none too strong for legislating any industry into federal restrictions or penitentiary penalties and bureaus. The only use for a national law is as a guide for state laws and if it is to be such, the same should be most conservatively and carefully considered. Every person interested commercially should be given an opportunity to be heard.

"The present idea of pernicious activity in federal legislation which will soon put every business man in many unprotected and defenseless industries into the position of working under the possibilities of a prison sentence is not an ideal occupation, in my judgment, for our congressmen."

Another: "We certainly are not in favor of the nurserymen spending any time or money in trying to procure a national uniform inspection law. Congress has no power whatever to change the different state laws and all shipments made would be subject to the different state laws just as soon as they crossed the state line.

"If we could have had a national law passed years ago before all the states had passed their own different laws, we think it would have been a good thing, but so far as we can now see, it would be simply putting one more burden upon the shippers with no corresponding benefits. We would simply have the provision of a national law to comply with in addition to the provision of every state into which we may be shipping.

"We do not know that we have any objection to a national uniform law only as stated above and we should be very much afraid that there would not be an appropriation made so that all nurserymen could have their nurseries inspected.

"We think at the stage to which the matter has now arrived, it would be a

good deal better to devote our energies to getting the state laws somewhat more uniform than to try to have a national bill passed."

Another says: "There are some 'IFS' in it.

"If all state laws were abolished or amended to conform to the national law, that would be all right, but they will not amend or abolish because that would be looked on as interference with that time-honored proposition of 'state rights.'

"If we could have a good national law to cover the whole business and all state laws out of the way, it would be a great gain, but as it appears to me, it would make further complications just now to try to have a national bill passed. We might have a national law to cover importations from foreign countries, provided it could be made to harmonize with the present state laws. As the matter stands, I do not feel that there is much to gain in the proposed legislation."

SUMMING UP THE WHOLE MATTER: The last letter puts it in a nutshell and it is now for you to decide—

First: If all state laws were abolished or amended to conform to a national law, that would be all right.

Second: They will not amend or abolish.

Third: What are we to gain by adding another law?

Fourth: Will it help the entomologists and inspectors in doing more efficient work or help the fruit-growers by adding another inspection?

I want to say I have given this some little time and quite a good deal of thought, and, after doing so, I would recommend that a resolution looking forward to making some definite arrangement for inspecting imported stock be adopted. But further than that I have no recommendation to make other than that based on the report.

ORLANDO HARRISON,
Committee on National Inspection Law.

The members of the visiting committee were then called upon for remarks. The purpose of the resolution which had previously been endorsed by the Association of Economic Entomologists and the Association of Horticultural Inspectors was fully explained and national legislation was pointed out as the best method of bringing about uniform regulations and practice in the inspection for stock received from foreign countries or for stock passing into interstate commerce. A motion was made and seconded that the report be accepted and, after a general discussion of the matter in which several nurserymen expressed their opinion that any national legislation was undesirable, it was passed unanimously.

At the afternoon session a resolution was offered by Mr. Kelsey of New York which was unanimously adopted and is as follows:

Resolved, That the vice-president of each state be and hereby is authorized on behalf of this association to use all reasonable endeavor to have any drastic legislation now in force in his state modified to conform to the laws of other states, the practical workings of which have not entailed undue hardship to the nurserymen or fruit-growers in their execution of such laws.

Resolved, That we heartily express our appreciation of the efforts made by the economic entomologists and horticultural inspectors of the country in their coöperation toward improving the insect pest legislation.

At the morning session, Thursday, the following resolution was presented by Mr. Hale of Tennessee which was designed to carry into effect the report which was adopted on the preceding day:

Resolved, That the American Association of Nurserymen in convention assembled do hereby endorse the passage of a law by Congress providing for the government inspection of all imports as follows:

SECTION 1. That it shall be the duty of the secretary of agriculture and he is hereby authorized and directed to prepare and promulgate rules and regulations governing importations of any trees, plants, shrubs, vines, grafts, cuttings and buds, commonly known as nursery stock, liable to harbor insect pests or plant diseases either by inspection by competent government employes of the United States Department of Agriculture, or by proper certification from officers of the nation or state from which such shipments were made, provided the same are accepted by the secretary of agriculture. When any such aforesaid nursery stock is offered for entry during the dormant season at any port in the United States, it shall be the duty of the secretary of agriculture, with the approval of the secretary of the treasury, to promulgate rules and regulations governing the inspection of said nursery stock at its destination. All nursery stock imported in accordance with the aforesaid regulations shall be free from all further inspection, quarantine or restrictions in interstate commerce; *provided, however*, that nothing herein contained shall prevent the inspection of such nursery stock by the authorized inspectors of any state or territory or the District of Columbia at the point of destination in accordance with the laws of said state or territory; and that sufficient appropriation be made by congress for this purpose.

Resolved further, That the committee on legislation of this association is hereby instructed to coöperate with the entomologists and inspectors in urging immediate action by congress.

This brought about a general discussion, several members taking the ground that the whole matter had been disposed of by the action taken on the previous day. Mr. Kelsey rose to a point of order and stated that it was his understanding that this was the case. President Hill ruled that the resolution submitted was in order, and, after a brief debate, it was referred to Mr. Pitkin of New York, who is the Legislative Committee of the Nurserymen's Association. No further report on the matter was presented to the meeting by the Legislative Committee at the remaining sessions.

Respectfully submitted,

THOMAS B. SYMONS,

A. F. BURGESS,

Members of Committee.

NOTES ON THE WORK AGAINST THE GYPSY MOTH

By E. P. Felt, *Albany, N. Y.*

The writer had the pleasure recently of spending several days examining the work against the gypsy moth. It is very gratifying, indeed, to state that there has been a marked gain all along the line. By far the greater part of the residential area is in most excellent condition, and while large tracts of woodland are badly infested and, in some instances at least, have been defoliated by the caterpillars, substantial progress is being made, particularly in methods of fighting the insect under such adverse conditions.

Entomologists will be specially interested in recent developments in spraying. The capacity of a spray outfit has been greatly enlarged by replacing the usual six-horse power gasoline engine weighing some 1,800 pounds, by a ten-horse power engine made especially for automobiles and weighing only 400 pounds. Though a heavier and more powerful pump is employed the whole outfit weighs no more than usual. The machinery is mounted upon a stout wagon with a 400-gallon tank. A heavy inch and a half hose, some 400 to 800 feet long with a smooth ¼-inch nozzle is used for work in the woodlands, and a pressure of 200 to 250 pounds maintained. The hose is handled much as though a fire was in progress. Ten men, at intervals of six or eight feet, carry the end of the line, the nozzle being in charge of a superior man, with instructions to keep it moving all the time. The pressure is sufficient to throw the insecticide forty to fifty feet, and the resistance of the air, breaking it into a fine spray, results in the foliage being well covered if the nozzle is handled intelligently. This large apparatus usually requires four horses and is capable of spraying 14 to 16 acres a day at a cost of about $10.20 per acre where the woodland is fairly clear of underbrush. An interesting modification is used for spraying along road sides. It simply consists of a giant extension nozzle mounted on a universal joint, so that the tip may be elevated forty or fifty feet from the ground. This latter is capable of covering a strip 400 feet wide if the wind be favorable.

The work with parasites is particularly interesting. The operations of last year have been greatly extended and a number of extremely valuable improvements made. Messrs. Fiske, Burgess and Townsend have charge, respectively, of the Hymenopterous, Coleopterous and Dipterous parasites. Several Hymenopterous parasites have been bred in large numbers and it is gratifying to state that many Japanese *Apanteles* have been reared upon American caterpillars. Furthermore, a new egg parasite of the gypsy moth has been received from

both Japan and Russia. Mr. Fiske is also working with an interesting egg parasite of the elm leaf beetle. The Coleoptera are receiving the undivided attention of Mr. Burgess. A recent communication has informed the writer that 1,200 larvæ of *Calosoma sycophanta* have been liberated. The work of Mr. Townsend with Tachina flies promises to give some exceedingly interesting results in the near future, particularly as he is now able to recognize the various imported species in any stage. These three gentlemen have an abundance of assistance and we look forward to most important developments within the next two or three years.

The efficiency of the laboratory and the comfort of the staff connected therewith, has been materially increased by the construction of several temporary insectaries or vivaria. One, in particular, is made of 2 x 4 scantling with nothing but a canvas roof and the sides closely covered with fine wire mosquito netting. This gives an abundance of room for breeding at a very slight cost. A larger building, devoted mostly to the breeding of Hymenopterous parasites, has a wooden roof covered with tarred paper and rough boarded sides, and, while admirably adapted for its purposes, is somewhat close and uncomfortable for work, being in this respect far inferior to the more temporary structure described above. Entomologists would get many useful hints from an inspection of this work, and we hope that in the near future some of the more interesting departures will be described in fuller detail.

White-Marked Tussock Moth

Hemerocampa leucostigma Sm. & Abb. This well known pest has caused extensive injuries to horsechestnuts in particular, in Brooklyn, New York, Albany, Troy, Utica, Syracuse, Rochester and Buffalo, the first and the last named cities probably suffering the greatest injury. This species has excited great interest in the fruit section of western New York by eating holes in young fruit much as do green fruit worms, *Xylina* sp., as high as 80% of the fruit being reported damaged in one instance.

Bag Worm

Thyridopteryx ephemeraeformis Haw. New York City and its vicinity represents about the northern extension of this species, as a rule. It was somewhat surprising, therefore, to receive healthy larvæ from Germantown, only about forty miles south of Albany. Mr. T. F. Niles, who sent in the specimens, states that no young trees have been set in this locality within the past two years, nearer than a quarter of a mile, consequently it would seem as though the species was able, under certain conditions, to maintain itself considerably farther north than has heretofore been supposed possible.

E. P. Felt, *Albany, N. Y.*

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN OF THE ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

AUGUST, 1908

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Reprints of contributions may be obtained at cost. Minor line figures will be reproduced without charge, but the engraving of larger illustrations must be borne by contributors or the electrotypes supplied. The receipt of all papers will be acknowledged.—Eds.

It is desirable at this time to once more call the attention of our readers to the fact that most of the matter for the October and December issues should come from working entomologists, not only in this country but also abroad. Our pages are open to all thoughtful contributions along economic lines. Our readers are deeply interested in special problems such as those presented by the gypsy moth work in Massachusetts, and particularly in that phase of the work relating to the introduction of beneficial parasites. New and improved methods are likewise of great importance, and the peculiar conditions governing entomological investigations in various portions of this country and even in foreign countries, are of great interest.

We wish to call the attention of our readers to the desirability of making public short notes of general scientific interest. There must be in the office files of most official entomologists throughout the country, items of this character. They are inaccessible at present and, under ordinary conditions, must remain so unless made public through some such medium as the Journal. A large number of such records, even though each relate to an apparently minor fact, would be of inestimable value and would do much toward making this publication indispensable to working entomologists. We all know, from previous experience, how extremely valuable the seven volumes of *Insect Life* have been, and in not a few instances much of this is due to the abundance of comparatively insignificant notes. One record calls to mind another and it is our expectation that the Journal will eventually become a storehouse for an extremely large number of facts covering every aspect of applied or economic entomology. The department of scientific notes should be a strong one in the October and December issues at least.

The program of the last few meetings of the Association of Eco-

nomic Entomologists has been exceptionally full, and we trust that this JOURNAL may become an agent in ameliorating the congestion. The value of the meetings lies not so much in the amount of information conveyed, as in the discussion of methods and results. There has been, in recent years, an increasingly large number of papers which might be grouped under the general head: Notes for the Year. There seems to be no particular reason why certain of these, at least, could not appear in either the October or December issues, thus reducing to a considerable extent the amount of matter awaiting publication early in January. We would therefore suggest that all writers contemplating preparing papers of this character for the coming meeting, bear this in mind and consider the advisability of submitting the same for publication prior to the annual session. There is no reason why individuals might not elect to do so, and there would be an advantage if this were generally done, since other workers could study the papers and be prepared to discuss the same at some designated period during the regular session. We see no objection to the extension of this practice to important contributions respecting insects or groups of insects or decided modifications in methods of work, particularly as there is a most obvious advantage in allowing an opportunity for careful study before a discussion. We believe that some such change in policy, which latter can be readily brought about by individual initiative, would result in marked benefits to all.

Current Notes

Conducted by the Associate Editor

At the last session of the Nebraska Legislature a law was passed establishing a state Insect Pest and Plant Disease Bureau, which under the provisions of the bill began activity on July 5, 1907. The work of the Bureau is carried on under the joint direction of the State Entomologist and the State Botanist, and for its maintenance the sum of $7,500 for the biennium was appropriated. The working staff of the entomology division is as follows: Lawrence Bruner, Chief of the Division and State Entomologist; Myron H. Swenk, Assistant Entomologist; Harry S. Smith, Assistant State Entomologist; R. W. Dawson, C. H. Gable and J. T. Zimmer, Laboratory Assistants in Entomology. An insectary and greenhouse costing $3,000 has been built on the grounds of the Experiment Station for the experimental work of the Bureau The purpose of the Bureau as set forth in the bill, is for the "investigation, control and extermination of insect pests and plant diseases through traveling experts, field work and laboratory research." When complaint of injury by insect pests is received a member of the staff visits the locality and investigates the trouble, which is discussed and the approved treatment advocated through the local press, or, if the trouble is widespread, through a

circular devoted to the insect. Two circulars and two bulletins have been issued by the Bureau.

At the last meeting of the Board of Trustees of the Massachusetts Agricultural College, Dr. Charles H. Fernald, for many years Professor of Zoölogy and Entomology at that institution, was elected Director of the Graduate School. This appointment comes as a tribute to the work of Dr. Fernald, who has been very active in securing graduate courses at that institution.

Dr. H. J. Franklin, who received the degree of Doctor of Philosophy at the Massachusetts Agricultural College in June, has accepted a position with the Minnesota State Entomologist at St. Anthony Park. He will teach Entomology in the University of Minnesota and conduct investigation work in the Experimental Station.

Mr. W. F. Turner, who received his Bachelor's degree from the department of Entomology at the Massachusetts Agricultural College, has been appointed Assistant to the State Entomologist of Alabama. He will be engaged in investigation work at the Agricultural Experiment Station.

Mr. J. G. Hyslop, who graduated from the same institution in June, has been appointed Assistant in the Bureau of Entomology, Washington, D. C.

Mr. C. C. Gowdy, who graduated in the class of 1908, Massachusetts Agricultural College, has secured a position as Assistant at the Gypsy Moth Parasite Laboratory, Melrose Highlands, Mass.

Mr. H. B. Filer, who graduated from the Massachusetts Agricultural College in 1906, and who since that time has been connected with the Shade Tree Commission in Newark, N. J., has been appointed City Forester of Buffalo, N. Y. He has charge of the shade trees and forestry interests and has been pushing the spray and other operations for the protection of the city trees against injurious insect pests with great vigor. There is need of more men in this line of work, judging from the poor condition of many shade trees in the eastern United States.

Prof. C. W. Howard, Entomologist of the Transvaal, South Africa, has resigned to accept a position with the Portuguese government. His headquarters will be at Delagoa Bay, South Africa.

Dr. F. Silvestri of the Scuola Superiore di Agricoltura at Portici, Italy, a foreign member of this Association, who is spending the summer in this country, recently visited the Gypsy Moth Parasite Laboratory at Melrose Highlands, Mass. Dr. Silvestri will spend considerable time examining entomological collections in the American Museum of Natural History in New York City. He will also visit California and some of the southern states before returning to Italy.

H. J. Quayle, Assistant Professor of Entomology in the University of California, began work July 1, 1908, at the Southern California Pathological Laboratory, Whittier, Cal., and is engaged in the study of some of the insects of the citrus fruits.

Prof. Charles S. Banks, Government Entomologist, Manila, P. I., spent several weeks in this country studying the collections at Washington, New York and Albany. He returns via Europe and will study the collections at the British Museum, Leyden, Brussels, Berlin, Stockholm and Turin. Prof. Banks has been giving particular attention to Culicidæ and has succeeded in rearing some extremely interesting forms.

Prof. C. W. Woodworth, Berkeley, Cal., spent a short time in the East, visiting some of the more important entomological centers.

The entomological course given at the Graduate School of Agriculture, held last month at Cornell University, has been well attended, and the entire session has been considered most successful by those responsible for the venture.

The Quebec Society for the Protection of Plants (from insects and fungus pests), was organized at a meeting held June 24 at Macdonald College. This society, as its name indicates, will be strongly of an economic nature. The headquarters for the society will be, for the present, Macdonald College. The following officers were elected for the ensuing year:

President, Prof. W. Lockhead, Macdonald College; Vice-President, Frère Liguori, La Trappe, Oka, P. Q.; Secretary-Treasurer, Douglas Weir, Macdonald College; Curator and Librarian, J. M. Swaine, Macdonald College; Directors, Rev. Dr. Fyles, Levis, P. Q., Rev. G. Ducharme, Rigaud, P. Q., A. F. Winn, Montreal, Auguste Dupuis, Village des Aulnaies, Dr. W. Grignon, Ste Adèle.

A substantial grant has been given the Society by the Quebec Department of Agriculture. As a large number of persons in the Province of Quebec are interested in the study of insects and fungi, it is believed that the new society will have a large membership, and will be able to do a great deal of work in the interests of agriculture.

Economic Entomology at Harvard University.—Replying to an inquiry, Prof. W. M. Wheeler states that during the coming year only two courses will be given; one by himself on the "Structure, Development and Habits of Insects," and one by Mr. Paul Hayhurst, recently appointed instructor, on "Common Economic Insects," both being intended primarily for graduate students. These courses begin February 1, 1909, the first semester being reserved for research work. Provision for the latter, commencing October 1 of the present year, has been made at the Bussey Institution, Forest Hills, Mass., where the entomological laboratories are situated.

Elm Leaf Beetle

Galerucella luteola Mull. The ravages of this pest continue in New York state, the elms of Albany, Troy, Schenectady, Schuylerville, Ithaca and those of some other localities in the Hudson Valley at least, being very badly injured, despite more or less sporadic efforts to control the insect. This species, under favorable conditions, produces two generations annually in the latitude of Albany. The experience of the past ten years has shown that the area of greatest injury in Albany is restricted to the older and more thickly settled fourth of the city. The comparative immunity of other parts of the municipality is probably due to the greater abundance of native birds, and presumably in part to fewer shelters where the beetles can hibernate successfully. This marked restriction was likewise very evident in Schenectady, the ravages of the beetle being particularly marked in the vicinity of an open belfry where the insects undoubtedly hibernated in large numbers.

E. P. Felt, *Albany, N. Y.*

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THE IMPORTATION OF TETRASTICHUS XANTHOMELAENAE (ROND.)

By L. O. HOWARD

The imported elm leaf-beetle (*Galerucella luteola*), first appeared in this country about 1837 at Baltimore, and has spread to the northeast above Boston and south into North Carolina. It has within comparatively recent years crossed the Appalachian chain of mountains and has begun to spread throughout the Middle West. It has practically no effective American natural enemies, and has increased and spread unchecked, except for such work as has been done by cities and towns and except for unfavorable climatic conditions. In Europe there exist one or more egg-parasites of this and congeneric hosts. In 1832 Boyer de Fonscolombe described one of these egg-parasites as *Pteromalus gallerucae*. In 1898 Kawall described *Pteromalus ooctonus* from the eggs of *Galerucella viburni*. In 1877 Rondani described *Oomyzus xanthomelaenae*. With the possible synonymy of these forms we have nothing to do.

In 1905 Dr. Paul Marchal published in the Bulletin de la Société Entomologique de France for February 22 a paper entitled "Observations Biologiques sur un Parasite de la Galéruque de l'Orme," to which he gave the name *Tetrastichus xanthomelaenae* (Rond.). In this very interesting article Doctor Marchal called attention to the fact that the elm leaf-beetle had multiplied for several years in a disastrous way about Paris, skeletonizing the leaves in the parks and along the avenues in much the same way as is so familiar to the residents of cities in the eastern United States. But with 1904 the ravages apparently stopped, and Marchal's observations indicated that this was largely if not entirely due to the work of this egg-parasite.

During June, 1904, he studied the habits of the species at Fontenay-aux-Roses, his suburban home just outside of Paris. His observations as published in the Bulletin are extremely interesting, and roughly translated are as follows:

"On the 26th of June, at Fontenay-aux-Roses, I collected some elm leaves that had been attacked by the beetle. Most of the eggs found on the surface of these leaves had long since hatched, and the larvae coming from them, in different degrees of development, were eating the parenchyma of the leaves. However, in spite of the late period, a good many eggs were yet unhatched, and among these there were certain ones which were gray in color, due to the presence of the little Chalcidid already formed and ready to issue.

"On the 28th these parasites came out in a receptacle in which the leaves had been enclosed. On the 29th and 30th I watched the ovipositing of the Chalcidid in some groups of elm-leaf beetle eggs that had not hatched and which were behind the great majority. Through the glass receptacle one could see the minute Hymenoptera stand for long periods upon the eggs of the beetle, and to observe a single individual it was quite possible, with the aid of forceps, to withdraw the leaf upon which it was placed and to examine it with a hand lens at leisure.

"In order to be perfectly exact, I will select an individual among those which I have reared, and will relate in succession all of its acts in accordance with notes taken in the course of my observation.

"The Tetrastichus is standing upon the summit of the egg of the Galerucella, a little to one side and in an almost vertical attitude; its abdomen is incurved. With the terminal pieces of the sheath, which emerge toward the point, it touches and marks the place where the ovipositor is to be introduced; the point of this, which issues from the ventral face, is placed just at the point indicated; then the extremity of the abdomen is lifted, and one then sees the piercing organ, which presents the aspect of a long, fine thread, penetrate, being directed a little obliquely toward the base of the egg. The operation is quite long, and lasts more than a minute. The insect raises and lowers its perforating apparatus several times without entirely withdrawing it from the egg, in which it remains inserted. It appears finally to penetrate quite to the bottom, and then, having remained some instants with its abdomen in contact with the egg, it withdraws the ovipositor. It then begins one of the most curious maneuvers, which makes the biological history of this insect quite original. As soon as the ovipositor is withdrawn, the parasite places its head at the point where the piercing organ has just been, and then licks with avidity the little wound which has just been made. Then it turns around and carries the extremity of the abdomen close to the wound. Then, with the terminal pieces of the ovipositor sheath, it feverishly gropes about, lowering them and raising them, and placing them here and there, until they place themselves exactly at the point of perforation. These movements are quite long, but as soon as the point is found the ovipositor penetrates a second time into the orifice, and remains there about half a minute. Then the insect withdraws it and, by a maneuver like that already described, licks the wound once more with avidity.

"The parasite then rests for some instants, and walks about the leaf in the neighborhood of the beetle eggs, but it returns rapidly to the egg which has

just been left and which it recognizes from all the others. It touches it with its palpi, makes an attempt, which does not seem to be entirely successful, to insert its ovipositor, and once more licks the wound. Then there is another and short walk in the vicinity, followed by a new visit to the same egg. This time the Tetrastichus inserts its ovipositor at exactly the same point that it did the two preceding times, holding it inserted about a minute. Then it is withdrawn, and the parasite licks the wound again in a very lively way. After this, without other interruptions than those of preliminary feeling and that of consecutive licking, it thrusts its ovipositor twenty times in succession into the egg. If we add the three preceding times, we reach the result that during the forty-five minutes that the observation lasted, the parasite thrust its ovipositor twenty-three times into the same egg of the beetle. All of the insertions were not identical, and the later ones, in a general way, were much more rapid than the earlier ones. About the middle of the series they lasted from a third of a minute to a half a minute; towards the end the insect took time only to insert the piercer and to withdraw it. The method, however, was the same in all cases, and always was accompanied by the preliminary feeling about and the licking of the place.

"The next day the egg which had been stung by the Tetrastichus was examined. It presented, near each other, four minute brownish spots, corresponding to the wounds made by the ovipositor. The insect, in order to avoid unnecessary trouble in searching again for the wound which it had previously made, occasionally made a new perforation when it could not find the old opening quickly enough.

"What can be the reason for this singular manœuver of the Tetrastichus? It is evident that the insect finds in the egg of the Galerucella a food which it likes, and that, using its ovipositor in another way than that which is habitually done with these Hymenoptera, it employs it as we use a pin to pierce the shell of an egg in order to suck its contents. If the wound which has just been made is too small to be found readily, it can be noticed that the place licked by the parasite is moist with the liquid which comes from the interior of the egg; often a real drop appears at the surface of the egg and is rapidly sucked up by the parasite.

"It cannot be doubted that one of the motives of the insect in giving its blows with the ovipositor is from its individual interest, but it is not less certain, on the other hand, as the fact even of its parasitism proves, that the Tetrastichus, conformably to the instinct of other Chalcididæ, uses its ovipositor to introduce its egg into the egg of the beetle. It seems that among all of the thrusts of the ovipositor which it gives, there can be only a small number intended for egg-laying. In opening the eggs of the egg groups most visited by the Tetrastichus I have discovered only a very limited number of eggs belonging to the parasite; but its ovoid, slightly incurved egg, about .023 mm. long, is relatively easy to discover, and it seems very certain that the number of eggs deposited is very far from being equal to the number of thrusts of the ovipositor. One can even suggest, in a general way, that the parasite does not place more than one egg in the egg of the beetle. On the other hand, one can open the egg of a beetle which has received a number of thrusts of the ovipositor without finding in its interior a single egg of the parasite.[1] And it seems to be a fact that in certain cases the Tetrastichus pierces the egg of the Galerucella exclusively to nourish itself.

[1]This was the case with the egg which has just been mentioned."

"My observations have not been sufficiently complete so that I can state that the egg-laying puncture is made in a different way from that just described, and that, for example, the numerous thrusts of the piercing organ may not be intended to disarrange the contents and to arrest the embryonic development.[1]

"If I can get sufficient material, it appears to me that it would be quite possible this year, by commencing to make these observations at an earlier date, to learn more accurately the history of the curious phenomena which accompany the egg laying of this species. I shall hope to find out also how the other generations go on and in what condition and in what stage the Tetrastichus passes the winter, and whether it can attack other eggs than those of the elm leaf-beetle."

Visiting Doctor Marchal in June, 1905, after the publication of this interesting article, the writer asked him whether he had been able to make his further observations, and he replied that the elm leaf-beetle had so entirely disappeared in the vicinity of Paris that he had not been able to do so. The writer urged him to make an effort through his correspondents to secure parasitized eggs of the Galerucella for sending to the United States in an effort to introduce and establish this important parasite on this side of the Atlantic. It was considered practically hopeless to attempt the introduction that summer, as the time was so late and it was not then known just in what part of France the elm leaf-beetle could be found abundantly. During 1906 practically the same conditions existed; a locality was found, but the parasites did not seem to be present. In 1907, reaching Paris about the first of May, the writer again reminded Doctor Marchal of his desire to import the parasite into the United States, and, meeting Mr. Charles Debreuil, of Melun, at the residence of the Baron de Guerne, the subject was brought up again, and M. Debreuil later in the season forwarded eggs of Galerucella to the United States, which were promptly sent to the parasite laboratory at North Saugus, Mass.; but the time was too late and the parasites had emerged and died.

In April, 1908, the Entomological Society of France was good enough to publish in its Bulletin (No. 7), page 86, a request from the writer that eggs of the elm Galerucella should be sent to the United States for the purpose of rearing parasites. This notice brought a speedy and effective response. About the 20th of May, Professor Valery Mayet, of Montpellier, France, a personal friend of the writer, secured a number of leaves of the European elm carrying egg-masses of the Galerucella, placed them in a tight tin box and mailed them to the writer's office in Washington. They were received on

[1] "This hypothesis appears to me somewhat probable. The arrest of the embryonic development of the host seems really a condition useful for the evolution of the egg of the parasite and one of the functions of the multiple thrusts of the ovipositor is rather probably to stop it.

May 28th and at once forwarded to Mr. W. F. Fiske, of the Bureau of Entomology, in charge of the parasite laboratory at Melrose Highlands, Massachusetts. This course was taken since at the time mentioned no localities for the elm leaf-beetle were known in Washington and for the past few years this species has been very destructive in the vicinity of Boston. The package was in some way or another subjected to considerable delay in its transmission from Washington to the laboratory at Melrose Highlands, but it finally arrived there on June 1st—twelve days from the time it started at Montpellier. The

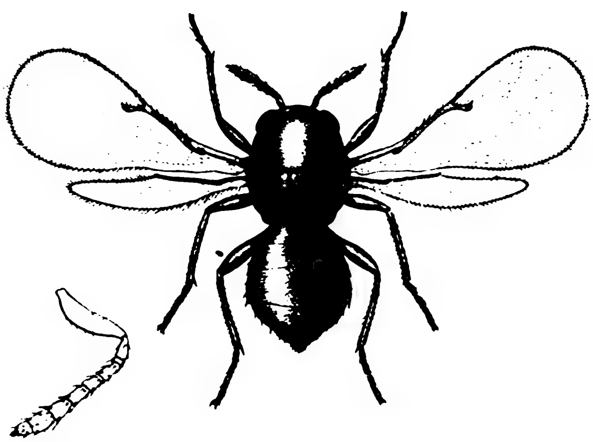

Fig. 7. *Tetrastichus xanthomelaenae* Rondani, adult female, very greatly enlarged; antenna, still more enlarged, at lower left.

early seasonal start was possible for the reason that Montpellier, as is well known, is in the extreme south of France. On opening the box, Mr. Fiske found a considerable number of active adults of the Tetrastichus. Most of them were placed in a large jar containing leaves of the elm upon which were newly deposited masses of the eggs of the Galerucella. This beetle was very abundant at Melrose at the time, and no difficulty was experienced in getting large quantities of eggs. A few parasites were used in reproduction experiments in small vials and tubes, but these experiments were not successful, since the eggs dried rapidly and the parasites themselves were short-lived in such extreme confinement. The females were at once attracted to the egg-masses, and probable oviposition was noticed within an hour after the receipt of the shipment.

Mr. Fiske was able to confirm most of Doctor Marchal's observations indicated in the translation above, but it appeared to him that the female did not always take as much time as Doctor Marchal's notes would indicate. They were several times noticed feeding upon

the contents of the egg as the contents issued from the wounds made by the ovipositor, and this appears habitual and probably necessary for the continued well-being of the adults. There were probably somewhat more than one hundred adults received in the shipment, and very few emerged from the imported egg-masses after the first day. Several different methods of rearing were tried, but the most successful were in the large jar already mentioned. In this jar adults lived surely for 35 days—a remarkable longevity, indicating that they are probably naturally active and engage in oviposition throughout the egg-laying period of the host.

From Mr. Fiske's notes, the following are quoted:

"On June 1, parasites placed in the jar.

"On June 4 they were still very active, and fresh foliage, with beetle eggs, was added.

"On June 8 another addition of fresh foliage with eggs was made.

"June 11, the parasites, of which the larger part were still alive, were carefully transferred to a fresh jar, with newly gathered egg-masses. The Tetrastichus continued active, and were noted ovipositing from day to day.

"June 18, the parasites were still active, and fresh foliage was added.

"June 23 the parasites still living were transferred to a fresh jar. There were at least twenty in all.

"June 26, they were still active, and fresh eggs were added.

"June 29, more fresh eggs were added; a number of the parasites were active and apparently ovipositing.

"July 1, there was still a small number of the parasites living, and these were carefully transferred to a fresh jar.

"July 5, several were noted still active, but after that date none was observed.

"Reproduction occurred in all of the jars above mentioned, though in the last it was very scanty. There is no possibility that any of the parasites noted from time to time were other than the originally imported females (the males died very soon after receipt), and the remarkable longevity of the species may be considered as established. It is reasonable to suppose that they would have lived longer in the open under natural conditions than in confinement

"Very few observations on the larval habits were made. The first larvae were found on June 9, at which time they were in what appeared to be their second stage They were, at this time, so small as to be almost invisible to the unassisted eye, and were very active when separated in a drop of water from the surrounding mass of the egg substance in which they were feeding. In this stage they are somewhat remarkable for an armature of minute spines a row of which borders each of the abdominal segments posteriorly. The last abdominal segment terminates with a somewhat more elaborate arrangement of spines

"After reaching this stage their growth is very rapid, and in three or four days more [illegible]st stage larvae were found commonly in egg masses from several

of the reproduction experiments which were conducted in large tubes. The first full-grown larvae were found on the 11th, but it is probable that these were more advanced upon the 9th than those actually observed upon that day.

"Young larvæ were found in eggs which contained the beetle embryo sufficiently developed to show traces of the legs and head. Many eggs containing embryos further advanced were examined at the same time, and, though these seemed to be dead as the result of oviposition by the parasite, no parasite larvae could be found. The parasite will oviposit, or appear to oviposit, in eggs containing beetle larvae fully formed, but it is doubtful if, under such circumstances, reproduction ensues.

"In laboratory reproduction it is better not to have the eggs too fresh, as they are much more likely to wither, if kept dry, or mold if kept damp, than eggs several days old. It was first supposed that perfectly fresh eggs would be better. A lot of beetles was confined indoors with elm leaves, and the newly deposited eggs used in reproduction experiments. All of these experiments were failures. In the open, with eggs on living foliage, the results would probably be different.

"Pupae were first noted on the 15th. The distinctive coloration of the parasitized eggs was also noted at this time, and it was found possible to separate those containing parasites by their color alone.

"These parasitized eggs are somewhat suggestive of those containing larvæ nearly ready to emerge, but lack the characteristic greenish hue. They are grayish in tint and have a dull, dead appearance. They are frequently somewhat withered, and in the case of those from the reproduction experiments were frequently covered with a scanty growth of mold.

"The first adults of the new generation emerged on June 21, and appeared in considerable numbers on that date. This would indicate a life cycle of 20 days, as it appeared that oviposition began at once upon the receipt of the parasites.

"Later generations developed more quickly. From the jar started on June 11, reproduction was secured on June 29, 18 days later. From the fresh egg-masses placed in the same jar on June 18, reproduction was secured 16 days later, on July 4. From the first lot of fresh eggs placed in the third jar, to which the parasites were transferred on June 23, abundant reproduction was secured on July 8, after but 15 days had elapsed. From the fresh eggs added to this jar on June 26, reproduction was secured on July 11, another fifteen-day period. The last jar, to which the parasites were transferred on July 1, contained, on July 15, adults in very small numbers, of what must be their progeny, indicating a life cycle of but 14 days.

"This gradual reduction in the length of the life cycle as the season advanced is peculiar, and no explanation is offered. The average temperature during the latter part of June and first of July was higher than during early June, but there hardly seems to be enough difference to account for six days shortening of the life cycle of an insect which develops as rapidly as Tetrastichus."

The adult parasites secured by laboratory reproduction were liberated in two localities near Boston, and parasitized eggs were sent to Prof. J. B. Smith at New Brunswick, New Jersey, and to Prof. M. V. Slingerland at Ithaca, New York, and the remainder were sent to

Washington, since about the middle of July considerable damage by the elm leaf-beetle was noticed in the latter city on certain streets.

The first of the Massachusetts colonies consisted of about 600 parasites, enclosed in an open tube and tied to a tree in Harvard Yard, Cambridge, on June 22d. Mr. Fiske thinks that more than a hundred adults found their freedom on the day of liberation and almost certainly the full 600 within a week thereafter. Fresh eggs were abundant upon the trees for some time thereafter, and the outlook there is very hopeful.

Writing on July 29, Mr. Fiske states that he has found eggs of the Galerucella nearly a quarter of a mile from the site of the colony, and that these appeared to be parasitized.

At Melrose Highlands, Mass., more than 1,200 adults were liberated between the 21st of June and the 8th of July, and unhatched eggs were noticed on to the end of July.

The eggs sent to Dr. John B. Smith reached him in good condition and a number of the parasites had already issued on the journey. They were very lively and he liberated them upon a small elm that had some egg clusters and is so situated that he will be able to watch it without difficulty during the summer of 1909. There are also plenty of large trees nearby, so that there will be no difficulty in the parasites flying from one tree to another. The number of parasites Doctor Smith considered to be too few to risk dividing them up.

From the material sent to Prof. Slingerland, at Ithaca, only a few adults issued, and before fresh eggs could be found these had died.

The parasitized egg masses received in Washington were taken to Dupont Circle, and the leaves upon which they were deposited were tied among the branches of the first elm on the north side of New Hampshire Avenue south of the Circle, and the fourth elm on the south side of the avenue. Native eggs were abundant.

So much for the introduction and rearing of a complete laboratory generation, and for the colonization of the species. As to the establishment of the species, there is one note to add. A small lot of fresh eggs collected in the vicinity of the Melrose field colony by Mr. Fiske produced a number of parasites on the morning of July 27. In consideration of the small number of eggs collected, it seems practically certain that there must have been a very abundant natural reproduction of the parasites and the probabilities are that the species at this date of writing exists in thousands at Melrose. The writer has every hope that the species will pass the winter successfully, and that the eggs laid next summer will be abundantly parasitized in the natural way.

The importance of this importation will be readily understood by all entomologists as well as by all shade-tree lovers, and it is an interesting example of what may be done in this way. The thanks of all good Americans are due to Doctor Marchal, Monsieur Debreuil, and Professor Valery Mayet for their assistance in this important work.

THE INTRODUCTION OF IRIDOMYRMEX HUMILIS (MAYR) INTO NEW ORLEANS

By E. Foster, *Vice-President Louisiana Society of Naturalists*

The exact period of the introduction of the ant *Iridomyrmex humilis* (Mayr) into New Orleans must necessarily remain somewhat of a mystery. The source from whence it came has been also the cause of some dispute among the citizens. On more than one occasion it has been advocated that the insect was introduced during the time of the Cotton Centennial Exposition, held in Audubon Park during 1884 and 1885, and only quite recently I have seen the view expressed in the public press that it first invaded the port by way of the Algiers and Gretna, or west side of the Mississippi River. For these theories there is, in my opinion, little foundation.

Prof. Wilmon Newell has named this pestiferous insect the "Argentine Ant," from the fact that it was first described from specimens collected during 1866 in the neighborhood of Buenos Ayres. Against the adoption of this proposed popular name there can be no objection, although the insect is well-known in Brazil, and from the fact that all evidence point to this latter country as the native habitat of the first individual, or batch of individuals to land on our wharves, it might more appropriately have been named after the "place where the nuts come from."

New Orleans has had no direct commercial intercourse with the Argentine Republic; at least, in the form in which such an insect would be likely to be introduced. In the case of Brazil, however, it is quite a different matter, for cargoes of coffee have been coming to New Orleans almost since the date of the Louisiana Purchase, and certainly since the passage of the Compromise Act of 1833, when the abolition of the duty gave a great impetus to importations. But it is needless to speculate as to whether the ant landed on the wharves as far back as that date, and, moreover, my days have not been "long enough in the land" to hark back for the better part of a century.

It is an axiom that an insect pest visitation starts somewhat like a fire which, if not quenched in the incipient stage, spreads rapidly once

it has got a good hold. We have the case of the cotton boll weevil in point. When this insect first crossed the border at Brownsville, Texas, it was looked on as something insignificant except by the few, and I may state without being accused of boasting, that among that small minority were numbered the officials of our State Experiment Station. Just how much the spread of the boll-weevil has cost our cotton planters during the few years it has been with us is well known. That *Iridomyrmex humilis*—that "stranger within our gates"—has been introduced and has spread to an extraordinary extent—to such an extent as to threaten at least two of our great staples, on the one hand through its care of scale insects and plant lice; on the other through its antagonism to certain species of beneficial insects, notably the ant *Solenopsis geminata*—there is now every evidence, and it is a question whether any effective measures can be started even at this early date and the insect's comparatively small range in the South. It is but another proof of the spreading of the fire through failure to quench it at the start, and I venture to say that hereafter the people of this section, at least, will give ear to the warnings of our economic entomologists.

From about 1891 to 1900 I was very much interested in the group of aculeate *Hymenoptera*, of which the ants form a no insignificant branch, and while my collecting was mainly confined to the Fossorial or "Digger" wasps, the hunt naturally led me more or less into contact with the *Formicidae*. During the early years of this period I collected rather assiduously along the levee front at Audubon Park and in the park itself, a field where the insect would have been comparatively conspicuous if it had been introduced by the exhibits at the Exposition of 1884-1885; at least, this can be assumed from our present knowledge as to its rapid increase. At that time our form of the large Carpenter Ant (*Camponotus herculeanus*, sub species *pennsylvanicus*) was quite a common insect, together with a very minute black ant which seems to live symbiotically; at least, that is the conclusion I have come to, for I have on many occasions found the two species together. What I took to be the American form, or one of the many subspecies of *Formica sanguinea* Fabr. was also present in numbers and the small yellow, or "pavement" ant *Monomorium pharaonis* Linn., also the red ant *Solenopsis geminata* Fabr. (the one with fire at both ends) were very abundant, while another comparatively large fuscous form with a darker patch on the thorax was to be found abundant on the trees fringing the river. There were others, notably *Lasius flavus* De Geer, but it is needless to go into their names even if I could place them definitely. To-day all of these species are

comparatively scarce in the Park section. *Iridomyrmex humilis,* which was then practically absent as far as my observations went, has almost displaced the lot. So much for the upper end of the city.

In 1893 my newspaper duties began to take me down daily into the neighborhood of the Sugar Exchange, or two squares below Canal Street and within a very short distance of the river. The variety or sub species of *F. sanguinea* was common; in fact, I watched one nest located at the corner of the sheds on N. Peters and Bienville streets until four years ago; since then it has mysteriously disappeared. Practically all of the species (with the exception of *Camponotus*), just noted for Audubon Park were quite common in this locality. *I. humilis* was present, but it was very scarce. Today this latter species seems to have almost completely supplanted the others and has become a veritable pest. Collecting at this period was also done in the neighborhood of the slaughter houses, some three miles below Canal Street. It was a rare insect there until 1895 or 1896. This covers my observations for the lower end of the city.

In these early days of entomological activity I lived on St. Charles Avenue, nine squares from the river and twelve from Canal Street. In 1891 the ant was there in fair numbers but in nothing like the hordes it is today. That it had made its way east from the river seventeen years ago may thus be taken as established; how far east I am unable to say, but I have no recollection of having seen it at this period at the West End resort on Lake Pontchartrain. Five or six years later I was living on Peters Avenue, near St. Charles Avenue and in the uptown district. *I. humilis* was then present but not abundant. Thus uptown it had extended its range not only to the north but east as well. In 1904 Mr. Titus, of the government Bureau of Entomology, found it prevalent all over this district, and across the Mississippi River as far west as Lafayette and Opelousas, while Mr. Newell now reports it from Lake Charles. In 1906 I did not notice it at the Gulf Biologic Station, some fifty miles south of Lake Charles, but I have little doubt but that it has reached there, seeing that there is constant steamboat communication between the two places.

I have no recollection of having seen the insect in the early nineties while collecting at Shell Beach, on Lake Borgne, neither have I any notes of its presence at Abita Springs, Slidell, Pearl River or Mandeville, all on the east side of Lake Pontchartrain and where it is decidedly the most abundant species now. *Solenopsis geminata* and *Monomorium pharaonis* were the most conspicuous of the red ants, while *C. herculeanus*, sub species *pennsylvanicus*, was just as common in the woods. At all of these stations *I. humilis* seems to be ousting all other species.

As to the possible site of its introduction: Mr. Chas. Dittmann, one of the best posted coffee importers in New Orleans, informs me that previous to 1890 all coffee steamers discharged at the wharves located between Julia and Orange streets, never further up the river than the latter; in other words, the landings were made within a distance of six blocks alongside the river, or from the 12th to 18th from Canal Street. Running east to St. Charles Avenue, this district would cover the house in which I resided in 1891, and where I first made acquaintance with the insect. This stretch of six blocks was, in my opinion, the starting point from which the insect has spread east, north, south and west; that it was there, and previous to the holding of the Cotton Centennial Exposition, the first invasion was made, for the rate of increase up to 1891 would necessarily be slow, but once started and nests established such increase would naturally become more pronounced, especially as we know that no steps were taken to check the advance. Moreover, at this date no note of complaint was heard, showing that the insect did not force itself on the attention of the ordinary observer by the mere fact of numbers; in fact, I believe that it was not until the year after the relaying of the street railroad tracks on Magazine Street (about 1895 or 1896) that the procession east became so pronounced as to cause general complaints, which were reëchoed in the press of the city. In the relaying of these tracks, numbers of nests would be disturbed and the ants driven to find new quarters.

The insect was first described by Gustav Mayr in 1868[1] in an obscure annual of the Society of Naturalists at Modena, Italy, under the name of *Hypoclinea humilis*, and from specimens collected during 1866 in the outskirts of Buenos Ayres. He described only the worker ant, and it was not until February of this year that on the request of Mr. Newell, full diagnoses of worker, male and female were published by Prof. W. M. Wheeler.[2] Mayr does not mention this species in his paper on the South American *Formicidae*,[3] published in 1887, nor in his list of the *Formicidae* of the United States,[4] published the previous year, the latter of which lists all forms known from this country at that date. It does not figure in Cresson's "Synopsis of the Hymenoptera of the United States," also published in 1887. If the insect had

[1]Formicidae novae americanae

[2]Jour Econ Ent., Vol. I, No. 1, Feb., 1908, pp. 28-30.

[3]Sudamerikanische Formiciden Verh. zool-bot. Ges. Wien, Vol. XXXVII, pp. 511-562

[4]Die Formiciden der Vereinigten Staaten von Nordamerika. XXXVI, p. 432 et seq.

become obnoxious at that date, I think the fact would have been noted in one or other of our entomological journals, and that Cresson would have been fully in touch with it, for his work shows that he had access practically to all the literature to date.

Mayr erected the genus *Iridomyrmex* in 1862,[1] and *Hypoclinea* in 1866.[2] The species *humilis* figures in his key[3] to the genus *Hypoclinea*, published in 1870. Six years later the two genera were combined by him, he having found many connecting forms. The literature of *I. humilis* may be small, but now that the insect has become such a serious economic pest, the mere systematic work of the entomologist will give place to that dealing with the biological side. The able article contributed by Mr. Newell to the initial number of this journal shows that a start has been made along the latter lines and much data gathered on the life-cycle and habits of the insect. With a full knowledge of such life-history, remedial measures may be possible, but the problem will be an extremely difficult one to solve and it goes without saying that every citizen of New Orleans, every sugar, cotton and rice planter, every florist and horticulturist will follow anxiously each step made towards that solution.

23d June, 1908.

NOTES ON SOME CECROPIA COCOONS AND PARASITES

By John B. Smith, Sc. D.

From a number of collectors reports came during the fall and winter of 1907–'08 of an unusual mortality in *cecropia* cocoons; or, more correctly stated, that an unusual number of the cocoons were "light," with remnants of untransformed larvæ only. In a discussion before the Newark Entomological Society at its February meeting, it appeared that this trouble was widespread and yet somewhat local. Some collectors reported a very high percentage of sound cocoons in limited areas and a yet higher percentage of "light" examples in others. So there was a great difference in the species, the cocoons of *promethea* and *cynthia* running normal and mostly good. Mr. Brehme reported an unusual dearth of *polyphemus* cocoons and explained that by the statement that an epidemic disease attacked the nearly full-grown caterpillars so that they never spun up at all.

It occurred to me that it might be interesting to learn a little more

[1] Myrmecologische Studien, p. 702.

[2] Ameisen des baltischen Bernsteins.

[3] Neue Formiciden, p. 959.

accurately the cause of these "light" cocoons and, in this day of discussion of parasites, to determine if possible the relative effectiveness of parasites and other causes in checking the development and increase of certain species.

I therefore asked Mr. H. H. Brehme of Newark and Mr. J. Doll of Brooklyn to gather and send me a lot of these "light" cocoons so that I might at least approximately determine the cause of death of the larvæ that spun them.

Mr. Brehme brought in a lot of 302 cocoons, of which nine turned out to be sound; eighteen were old specimens from which the adults had emerged; forty-two were parasitized and 233 had died in the larval stage, of disease. Of the forty-two that were parasitized only a few were infested by *Ophion*, while the remainder appeared to be infested by some species that makes its cocoons in a mass.

The dead larvæ were in most cases mere shells and were filled with a powdery mass. There was some difference, however, and I judged that at least two kinds of disease organisms had been responsible for death. The interesting feature in the matter is that less than 15 per cent of the deaths had been caused by parasites and over 65 per cent by disease.

It was quite possible to separate out two series of cocoons containing diseased larvæ. In 59 of the 233, the cocoon was incomplete or imperfect; *i. e.*, the inner cocoon was very thin or practically wanting, or the outer cocoon was reduced to a mere covering of loose silk. In other words, the vitality of the larva had not been sufficient to enable the caterpillar to do its spinning work properly, although death did not ensue until after it was completed.

Two lots of cocoons were sent in by Mr. Doll, one consisting of 430 and the other of 330 specimens. Both lots were collected between Maspeth and Laurel Hill, Long Island, one lot, the 430, during the fall of 1907, the second lot, 330, during March, 1908. In the first lot the object had been to collect good cocoons and the obviously light ones were rejected in the field; in the second lot all light cocoons were taken. The first lot was part of a much larger number—over 2,000—collected as probably sound, and the material sent me was that which was sorted out as probably bad when they were again tested at home. In neither case does the material afford any clue as to the actual percentage of infestation; it simply indicates the percentage of the different causes of death.

In the lot collected in 1907, sixteen cocoons were found to contain sound pupæ, and from fifteen adults had issued, leaving 399 that had dead larvæ or pupæ. Thirty four caterpillars had reached the

pupal stage and died. Of these some had masses of white, fungous-like material with a surface coating of orange powder exuding between the segments. Others were drying up and shrivelling; a few contained a putrifying mass of yellowish material. Of the remainder, 213 were dead as larvæ and of these fifty-four had made light or imperfect cocoons. One hundred and fifty-two were parasitized, and of these twenty had *Ophion* cocoons, the remainder seeming to be Ichneumonids of some kind.

In the lot collected in 1908, eleven cocoons were found to contain sound pupæ and from one the adult had emerged. Thirteen had died in the pupal stage, leaving 305 that had died without pupating. Of these 204 were killed by disease, sixty-one of them making light cocoons, while 101, or less than half as many, were parasitized. Of those that were parasitized, fifty-six contained pupæ of *Ophion*, while forty-five only went to other species.

This little examination is interesting because it calls attention to the relative importance of control factors other than parasites. It gives the results from a lot of 1062 specimens and shows that 697, or more than 65 per cent, were killed by disease in either the larval or pupal stage.

I am quite aware that the statistics are incomplete and imperfect, since the collections were not made of *all* the cocoons in a given region; but as they go, they emphasize the importance of a study of the subject from a new standpoint.

Stated in compact form the results of the study are as follows:

Total number of cocoons examined..........		1062
Sound specimens..........................	36	
Adults had emerged.......................	34	
Died as pupæ.............................	47	
Parasitized	295	
Dead from disease........................	650	1062

The above results were secured by early summer and were communicated to the Brooklyn Entomological Society at its June meeting. At that time it was announced that the parasites had begun to make their appearance and that the cocoons would be preserved until the record was complete and nothing further issued.

To all appearance there were two kinds of parasites, the *Ophion macrurum*, which was of course readily recognizable, and an Ichneumonid form, making its cocoons in a solid mass in the lumen of the *cecropia* cocoons. There were seventy-six counted *Ophion* pupæ and from these nineteen adults were obtained. As the *Ophion* speci

mens in the Brehme lot were not counted, it means that less than twenty-five per cent of the total number matured, and that was not because of any hyperparasitism, but a simple failure of the larva to make a proper pupa. This experience by the by, is not a new one to me. In years past I have cut *Ophion* cocoons in large numbers, finding sound larvæ and pupæ as exceptions only and a putrid brown semi-liquid mass as the rule. Mr. Grossbeck informs me that he has never found anything but the same pasty mass, and therefore it seems that this parasite is kept in check by some disease that reaches it within the body of its host.

Assuming that there were actually eighty *Ophion* parasites, that left remaining 215 *cecropia* cocoons containing massed Ichneumonid cocoons. The number of individuals in these masses was not determined, but there were certainly more than ten, which would make an expectation of 2,000 parasite examples a very moderate one. Instead of that we bred out, *Spilocryptus extremis*, 124 specimens, *Spilochalcis mariae*, 51 specimens; a total of 176 examples instead of the expected 2,000.

But we were not left without specimens for count, because we bred out over 48,000 examples of *Dibrachys boucheanus* or some very closely allied form. The species was referred through Dr. L. O. Howard to Mr. J. C. Crawford, and the determination was received as above, with the statement that this was a hyperparasite on Ichneumonidæ. Mr. Grossbeck actually counted 33,000 of the little specimens and estimated the balance; conservatively, I am certain, for I myself believe that the total was nearer to 50,000 examples. Assuming that the 176 *Spilocryptus* and *Spilochalcis* were the product of fifteen cocoons, that left the nearly 50,000 examples to emerge from 200 cocoons, or 250 examples from each cocoon; twenty-five hyperparasites from every true parasite.

Actually there were over 280 hyperparasites to every primary parasite and this would seem to afford a very decent check to undue increase, so as to prevent the complete extermination of *cecropia* by parasites alone.

This series of notes is published at this time as a suggestion to some of our younger investigators. An extremely valuable set of data can be secured by collecting in some limited locality *all* the cocoons of some of our large *Bombycids*, sorting them so as to separate sound from dead or parasitized forms and sorting the latter so as to separate the different kinds of parasites so far as these may be determined without interfering with their development. Collections should be made in late fall and in late spring to determine the influence of

the winter, and in due time facts would be at hand enabling us to judge intelligently concerning the actual effectiveness of parasitic checks, for some species at least.

There is always a good chance of being misunderstood, hence it may be in place for me to say that I do not mean to suggest that parasites are of no use in checking insect increase. I know that they are. But I do claim that we do not know just where parasites rank in effectiveness as compared with other conditions, and I do claim also that, however much under parasitic control some species may be, that is no proof that therefore all other species may be or are similarly controlled. The contrary proposition is, of course, equally true.

NOTES ON THE LESSER CLOVER-LEAF BEETLE

(*Phytonomus nigrirostris* Fab.)

By C. O. Houghton, *Newark, Del.*

This species is quite common in Delaware, where, in company with its near relative, *P. punctatus* Fab., it at times does considerable damage to clover.

The earliest date on which I have taken this species in the field in Delaware is April 12; this was in 1906. On that day I found a single brightly-colored specimen several inches down in a hollow weed-stalk, three or four feet high, in a field. I also took, on the same date, about a dozen specimens as they were floating on the water in a small ice-pond near Newark. There must have been several hundred specimens on the pond at this time, as a large number of others were seen. Apparently they had fallen into the water as they were flying over it, possibly due to the fact that quite a strong wind was blowing.

In 1905 my first specimens were taken on May 9, on which date I found three at the bases of clover plants in a sunny spot beside a railroad track. All three specimens were bright and fresh, the green being very brilliant. I placed these specimens together in a shell vial containing a few clover leaves, and soon after noticed two of the beetles apparently pairing. The next day two more specimens were taken and enclosed with the others, and that evening two pairs were observed mating. They did not appear to mind confinement and fed freely upon the clover leaves, eating small irregular holes or slits in them; they also fed somewhat upon the stems.

On the morning of May 11th the pairs were still together, and

they were observed similarly disposed at various times during the next few days. On May 17th I removed the leaves from the vial and carefully examined them for eggs. Several were found situated inter-epidermally, sometimes singly, sometimes in pairs. They were inserted through punctures sometimes made through the upper epidermis of the leaf, sometimes through the lower, apparently. These eggs were whitish in color, elliptical in outline, and measured .55-.6 mm. in length by .35-.4 mm. in width.

The development of this lot of eggs was not watched, but some that were deposited during the twenty-four hours preceding the evening of May 20, and which were dissected on May 28, were found to contain embryos apparently full grown. Again, newly hatched larvæ were found May 29 on a clover leaf which contained eggs laid during the twenty-four hours preceding the evening of May 22. Thus the time elapsing between the deposition of the eggs and the hatching of the larvæ in these two instances was about eight days. In both cases the vials containing the clover leaves were kept in a moderately cool and dark room in the house, where the temperature probably averaged 60° to 70° F. The first pupa that I obtained was from a larva which hatched in the field and was brought in a few days before it pupated. This pupa was found on May 23, and there was no sign of a cocoon. It was found lying on a leaf, with no evident attempt at concealment. When touched it wriggled vigorously.

About June 1st the first pupa in its cocoon was found. This cocoon was not unlike that of *P. punctatus*, except, of course, that it was much smaller and appeared to be more carelessly constructed. It seemed to be rougher on the outside, and the meshes not so evenly formed as in the average cocoon of its near relative. It was formed at the top of the vial, between a piece of paper and the cork.

On June 6 I found another cocoon, containing a pupa, which was attached to one of a bunch of clover leaves in a vial. Later (on June 16) I found a cocoon snugly ensconced in a clover blossom that was in one of my vials. The duration of the pupa state in one case that I observed was about four days—not more. This specimen was kept under conditions similar to those described above for the eggs.

A beetle that emerged on June 15 began at once to feed upon its cocoon and soon completely devoured it. In this case the vial enclosing the beetle had nothing else in it. Lack of other food probably accounted for this apparently peculiar proceeding, as I observed no other similar case.

None of the larvæ which hatched in confinement were carried through to maturity, so I have no data bearing upon the length of

time required for their development. Many of the larvæ which I had under observation died after reaching full growth and before pupating. They would turn black and die in a short time. Some of my pupæ suffered the same fate. No investigation of the cause of death was made in these cases, but it seems probable that a fungus disease similar to, if not identical with, the one which works upon the larvæ of *P. punctatus* was responsible for it.

I failed to record measurements for newly-hatched larvæ, but some brief notes jotted down on May 28 are as follows: "Found two or three newly-hatched larvæ upon a clover leaf which contained eggs laid during the twenty-four hours preceding the evening of May 22. These may have been out a few hours, but not longer, I think. Larvæ are white, with black heads, and a transverse black bar just back of the head, on top of the first thoracic segment, apparently." Some larvæ which appeared to be full grown and had stopped feeding were measured on May 25. They averaged about 7 mm. in length, one measuring 7.5 mm.

As evidence that the egg-laying period of this species may extend over a period of several days, I may say that on May 25 I put the original five specimens (some of which had deposited eggs previous to May 17) upon a potted clover plant under a bell jar and within eight hours several eggs had been laid, some in the usual manner and some otherwise. The unusual way in which part of the eggs were laid in this case was that a bunch of six, somewhat irregularly stuck together, was deposited upon one of the leaves.

Judging from my observations upon the feeding habits of this species, and its near relative, it is an easy matter to determine from an examination of an injured clover leaf whether this has been fed upon by the adults or larvæ of *P. nigrirostris* or those of *P. punctatus.* The former eat small holes and slits in the leaves, often near the center; the latter begin at the edges of the leaves and eat into them from the outside.

In closing these random notes on the lesser clover-leaf beetle, it may not be out of place to add a brief note made by the writer in northern New York (at Potsdam, St. Lawrence Co.) in 1902. The date is July 17, and the note is as follows: "Today I collected a larva of this species, about one third of an inch in length, which was feeding on clover. It was near the top and at the center of the plant, and had destroyed a good deal of that portion of it. I put the larva into a small bottle with some of the clover and left it, corked up, for some time. About July 28 I saw that it had turned to a pupa, and on August 1, I found the adult in the bottle."

Although *P. nigrirostris* is very common in northern New York and I have taken numerous specimens while collecting, I have made no other observations on its habits in that region. Specimens in my collection which were taken at Potsdam bear dates ranging from March 19 to August 1. As the former date is too early to expect any transformations to have taken place, it seems probable that this species hibernates as an adult.

THE OVIPOSITION OF CHILOCORUS BIVULNERUS MULSANT

By A. A. Girault

As there have been no very complete observations recorded in the literature of economic entomology in regard to the place of deposition, and the morphology, of the egg of this scale-eating ladybird, the following description of it and record of observations on the place of deposition may be of contributory value, particularly since previous observations are not in accordance with these and are more or less fragmentary.

The egg of this species has never been described, and I believe the first observation made on its place of deposition was by Fiske (1903) in Georgia, who stated that they were found in rather large numbers on the trunk of old peach trees infested with the cherry scale (*Aspidiotus forbesi* Johnson). The eggs were deposited under the coccids, in a manner somewhat similar to the mode of deposition of *Chilocorus similis* Rossi (Marlatt, 1902, 1906). However, Smith (1897) mentioned their color, relative size and shape and stated that they are "set on end in little groups, * * * and in a general way resembling the eggs of other ladybirds * *." And years previously, Townend Glover (1859) wrote that they were deposited on the leaves and trunks of trees infested with coccids. Dimmock (1906) gives no additional data.

For the past two or three years I have made more or less desultory observations on *bivulnerus*, but did not find its eggs until the middle of April, 1907, at Olden, Missouri. On a trunk of an apple tree infested with *Chionaspis furfura* (Fitch), the adults were quite abundant, and careful searches under loose pieces of the outer bark and in small crevices along the trunk disclosed the eggs deposited in such places. None were found under the coccids. I was able to prove these eggs to be those of *bivulnerus* several months later when at New Richmond, Ohio, in June, 1907, a pair of the beetles in confine-

ment deposited several eggs, in all respects identical with those found deposited along the trunk of the apple tree in Missouri. A careful description of the eggs in both cases was made. They were deposited on their sides under both conditions, but in confinement I did not succeed in getting more than the few mentioned.

Again at Urbana, Illinois, May 28, 29, 1908, several females of this species were observed crawling slowly about amongst an isolated but crowded colony of *Lepidosaphes ulmi* (Linnaeus), on the trunk of a Carolina poplar (*Populus deltoides carolina* L.), on the campus of the University of Illinois. They were watched for four hours during the afternoon of May 28, but none were observed to deposit eggs, though their ovipositors were quite frequently exserted and inserted into crevices and openings along the bark. The females were very deliberate in their movements, crawling slowly about examining all likely crevices, stopping frequently to feed upon the minute young coccids, and occasionally to rest. They seemed to be particularly careful in selecting a place for the nidus, if such was their purpose. It was not until waiting several hours on the following morning that actual deposition was observed. The females were behaving as formerly, but at 11 a. m., May 29, one of them paused longer than usual while examining a crevice with the ovipositor, and finally she was seen to pass a single egg. This was deposited under a scale of bark, and the egg was very well hidden. This egg was cut out of the crevice and compared with the others found scattered in similar places through the coccid colony, and all of the females were captured and confined in the laboratory, where, however, they died from neglect, without oviposition. All the eggs found in this colony of Lepidosaphes hatched in the laboratory, but I did not have time to secure data on the length of the egg instar. After death the females were kindly determined for me by Mr. Eugene A. Schwarz of the United States National Museum, Washington, D. C., as the species under consideration.

The description of the egg is appended:

Normal: Color uniformly pale chrome orange; cylindrical, slightly thickened towards the middle, the ends obtuse, subtruncate; surface shining, naked, minutely punctate (half-inch Coddington lens), with moderately close, minute papillæ, within rather large, circular, deep punctures (two-thirds-inch objective, Bausch and Lomb), the latter inconspicuous, seen faintly at the change of focus, as of an uneven surface; papillæ resemble minute punctures. Micropyle inconspicuous; chorion elastic. Length, 1.20 mm., average; greatest width, 0.65 mm., average. (From 14 specimens.)

Deposited singly or in small groups of three or four, on their sides, in crevices of the bark; attached, however, at the caudal end, along the laterocaudal margin of one side, making that margin of the egg somewhat obliquely truncate. The eggs are larger than with the more common species of the

Coccinellidæ and appear to be similar to those of *Chilocorus similis* Rossi (Marlatt, 1906). Fiske (1903) states that they are brown in color.

Literature Referred To

1859. **Glover, Townend.** Report Commissioner of Patents for the year 1858. (Executive Document No. 105, House of Representatives, 2d session 35th U. S. Congress), Washington, p. 261. "The eggs of this lady-bug being deposited by the female on the leaves or trunks of trees infested, hatch in from three to six days."

1897. **Smith, John Bernhard.** Report of the Entomologist (for 1896), in 17th Annual Report, New Jersey Agric. Experiment Station, for year ending Oct. 31, 1896, p. 522. "The eggs are bright yellow in color, and quite large in proportion to the size of the beetle. They are elongate-oval in shape, set on end in little groups, something like those of the Potato Beetle, and in a general way resembling the eggs of other lady-birds, which are not uncommonly found on leaves infested by plant lice."

1902. **Marlatt, Charles Lester.** Proceedings of the 14th Annual Meeting of the Association of Economic Entomologists, Pittsburg, Pa., June 28, 1902. Bull. No. 37, N. Series, Div. Ent., United States Department of Agriculture, Washington, D. C., p. 81.

1903. **Fiske, William F.** Proceedings of the 15th Annual Meeting of the Association of Economic Entomologists, Washington, D. C., Dec. 26, 1902. Bull. No. 40, N. series, Div. Ent., United States Department of Agriculture, Washington, D. C., p. 31.

1906. **Dimmock, George W.** Algunas Coccinellidæ de Cuba. Primer Informe Anual de la Estacion Central Agronómica de Cuba, Habana, pp. 291-292. Mentions the observations of Glover (1859), Smith (1897), and Fiske (1903).

1906. **Marlatt, Charles Lester.** The San José or Chinese Scale. Bull No. 62, Bureau Ent., United States Department of Agriculture, Washington, D. C., fig. 11, d g.

NOTES AND DESCRIPTIONS OF SOME ORCHARD PLANT LICE OF THE FAMILY APHIDIDAE[1]

By C. P. Gillette

The Aphididæ have been the most destructive family of insects attacking Colorado orchards for several years past. Consequently they have been objects of special study by the writer and his assistants for the last two or three years. I am giving here some of the more technical information, especially descriptions, that would be of little interest to the fruit grower.

[1]This paper is supplemental to Bull. 133 of the Colorado Agricultural Experiment Station, which deals more specially with the life habits and the means of control of orchard plant lice.

I am specially indebted to Mr. L. C. Bragg and Mr. E. P. Taylor for many of the life-history and food-plant records, and Miss M. A. Palmer has made all the drawings for the illustrations.

APHIDS INFESTING APPLE AND PEAR TREES

The Green Apple Aphis, *Aphis pomi*, DeGeer; Plate 5, figs. 1–8.

Some of the More Important Literature

Aphis pomi, n. sp. DeGeer, Memoires, III, 1773.
Aphis pyri mali, Fab. Systema Entomologica, 1775.
Aphis mali, Kaltenbach, Mon. der Fam. Pflanzenlouse, p. 72, 1843.
Aphis mali, Koch, Die Pflanzenlouse, p. 107, 1857.
Aphis mali, Buckton, Mon. British Aphides, II, p. 44, 1879.
Aphis mali, J. B. Smith, Bull. 143, N. J. Exp. Sta., 1900.
Aphis padi, Sanderson, 12th Rep. Del. Exp. Sta., p. 191, 1901.
Aphis pomi, Sanderson, 13th Rep. Del. Exp. Sta., p. 130, 1902.
Aphis mali, Quaintance, Circular 81, Bureau of Ent., 1907.

Eggs—The eggs vary little from .60 mm. in length by .26 mm. in transverse diameter. When first deposited, they are light green in color, but in the course of a few days change to deep polished black. They are scattered promiscuously over the smooth bark of the twigs. Upon hatching the shell splits longitudinally at one end, as shown on Plate 6, Fig. 20. Hatching begins several days before the apple buds open at all, or with the opening of the earliest apricot blossoms in the same neighborhood.

Young Stem-mother—Plate 5, fig. 1.

The young stem-mothers, before the first molt, are very dark green in general color; antennæ and legs dusky yellowish green; cornicles very short and black; antennæ stout, 5-jointed,[1] and with sensoria at the distal ends of joints 3 and 4. Length of body, in specimens described, .60 mm.; length of antennæ .28 mm. From eggs taken at Paonia, Colorado, on apple, March 2, 1907.

Adult Stem-mother—Plate 5, fig. 2; and plate 6, fig. 1.

From the same source as the preceding and hatched and reared in the insectary, probably a little under size.

Color a bright green with a little tinge of yellow, head more or less conspicuously dusky brown; cornicles, cauda, eyes, base and tip of beak, tarsi, distal portions of tibiæ, and antennæ, the knees and genital plates, black or blackish; remaining portions of legs and antennæ a little dusky. The lateral thoracic tubercles are present, and similar ones occur on part or all the abdominal segments to the 7th; cornicles nearly straight and gradually tapering to their distal ends. The antennæ are short and 6-jointed, as is usually true with stem-mothers in this genus. The third joint is very much the longest (Plate 6, fig. 1) and is really the union of joints 3 and 4. Sometimes the suture is present, cutting this joint into two. Length of body varying little from 1.50 mm.; width, .80 to .90 mm.; antenna, .75 mm.; antenna joints: three, .26 mm.; four, .13 mm.; five, .11 mm.; six, .14 mm.; cornicles, .25 mm.

Young of Stem-mothers—Plate 5, fig. 4.

[1]For convenience I shall refer to the flagellum of the last joint of the antenna as a separate joint.

The young lice of the second generation, before their first molt, are a very pale yellowish green with light to dark red eyes and with legs and antennæ pale dusky. Antennæ with third joint longest, nearly equalling joints four and five together, whole number of joints five, sensoria at distal ends of joints three and four. The head is large and broad, the thoracic tubercles are well developed and about five similar tubercles occur along either lateral margin of the abdomen; the cornicles are very stout, being about as broad as long and about parallel sided. Length of body, .60 to .65 mm.; antenna .35 to .40 mm.

Adult Apterous Viviparous Female—Plate 5, fig. 3; and Plate 6, fig. 2.

Described from same lot as preceding young.

General color light green or yellowish green with head, or head and thorax, distinctly yellowish, the head in some specimens somewhat dusky; cornicles, eyes, tarsi, genital plates, cauda, knees, distal ends of tibiæ and more or less of the distal ends of joints four, five and six of the antennæ dusky brown to deep black. Thoracic tubercles distinct, about four to six similar but smaller lateral abdominal tubercles upon either side; cornicles straight and slightly tapering to the outer ends, where there is a moderate flange; cauda upturned, tail-like; vertex gently rounded, antennal tubercles very slight; body pyriform in general shape. Length varying from 1.60 to 2 mm.; length of antenna, 1.20 mm., joint seven usually a little the longest, joints four and five subequal (Plate 6, fig. 2); length of cornicles somewhat variable but differing little from .40 mm.; cauda, .19 mm. The orange color at base of cornicles as described by Sanderson in Thirteenth Annual Report, Del. Experiment Station, 1901, I have never seen at any time of the year in this species

Pupa of Viviparous Female Plate 5, fig. 6.

In third generation, bred from stem-mothers described above

Color of abdomen green, more or less tinged with yellow; thorax, above and below, yellowish brown, to pale carneous, the color being deepest on prothorax and middle portion of mesothorax; head of same color with more or less dusky brown that is separated into two lateral patches more or less distinctly by a median lighter line; distal ends of antennæ, eyes, cornicles, wing pads, tarsi, distal ends of tibiæ, most of the femora, and beak, and genital plates black or blackish cauda green, more or less infuscated about the margins, thoracic and abdominal tubercles as in Apterous Viviparous female. Length of body about 1.80 to 2 mm., antenna, 1 to 1.10 mm.; cornicles, .32 mm.

Winged Viviparous Female Plate 5, fig 6, and Plate 6, fig. 3

Third generation as in case of pupa described above

Color of abdomen deep green without black markings above;[1] head, thorax above and below, cornicles, cauda, genital plates, tarsi and distal ends of tibiæ and [illegible] black or blackish, costal vein and stigma dusky, venation normal [illegible] appearing black, lateral tubercles present on prothorax and [illegible] of the abdominal segments middle ocellus upon vertex [illegible] upon slight tubercles third joint with about 6 to [illegible] row, cornicles very gradually [illegible] distal ends where there is a moderate flange. Length of body [illegible] antenna 1.15 to 1.25 mm. Joints of antenna about

[1] [illegible] margin of the abdomen, three [illegible] black spots that occur in [illegible]

as follows: Three, .25 mm.; four, .20 mm.; five, .19 mm.; six, .12 mm.; seven, .30 mm. (Plate 6, fig. 3). The antennæ and cornicles of seven alate females from Mr. J. T. Monell taken at St. Louis, Missouri, June 10, 1908, measured as follows in hundredths of millimeters:

Joint 3.	Joint 4.	Joint 5.	Joint 6.	Joint 7.	Cornicle.
26	20	20	12	33	31
29	19	20	11	33	31
29	20	20	11	31	29
27	19	19	11	29	29
26	20	19	11	31	26
27	20	20	11	34	29
31	20	20	12	33	29

The antennæ and cornicles of nine alate females taken at Fort Collins, Colorado, July 10 to August 14, 1908, measured as follows:

Joint 3.	Joint 4.	Joint 5.	Joint 6.	Joint 7.	Cornicle.
27	20	20	12	29	30
26	20	20	11	30	29
34	28	21	11	34	30
28	20	20	11	29	30
29	20	20	11	34	29
27	21	20	12	31	29
29	20	20	11	31	29
31	21	21	12	34	30
29	21	20	11	31	29

Oviparous Female—Plate 5, fig. 8; and Plate 6, figs. 5, 6.

Wingless, variable, but usually dull green in general color with a tinge of rusty yellow; head dusky brown, quite dark in some individuals; eyes, distal half of antennæ, cornicles, cauda, knees, distal ends of tibiæ, tarsi and genital plates black or blackish; thoracic tubercles prominent and a row of smaller ones along either lateral margin of the abdomen; cornicles straight and tapering gradually towards distal ends, where there is a slight flange. Length of body varying little from 1.40 mm.; antenna, .85 mm.; seventh joint fully one-third longer than joint three (Plate 6, fig. 5). Sensoria at the distal ends of joints five and six only. About 10 oval sensoria on hind tibiæ (Plate 6, fig. 6).

Apterous Male—Plate 5, fig. 7; and Plate 6, fig. 4.

General color brownish yellow with dusky brown head. Eyes, cornicles, cauda, genital plates, tarsi, distal ends of tibiæ, and more or less of distal ends of antennæ black or blackish; older individuals darker than the younger; length of body, 1.10 mm.; antenna, .90 mm.; cornicles, .15 mm., cylindrical,

moderate flange at distal end. Antenna joints: Three, .19 mm.; four, .17 mm.; five, .14 mm.; six, .09 mm.; seven, .23 mm. long. The sensoria are difficult to see and appear to be variable in number. Near distal end of joint three I have usually found 2 and upon joints four and five about 7 or 8 each (Plate 6, fig. 4). Described from specimens taken September 15, 1907, at Fort Collins.

The Woolly Apple Aphis, *Schizoneura lanigera* Hausm., Plate 5, figs. 9, 10, 11.

Some of the More Important Literature

Aphis lanigera Hausm., Illigers Mag. I, p. 229, 1802.
Schizoneura lanigera Hartig, Germar's Zeit. Ent. III, p. 367, 1841.
Pemphigus pyri Fitch, 1st Rep. Ins. N. Y., p. 5, 1856.
Aphis lanigera Harris, Ins. Inj. to Veg., p. 242, 1862.
Eriosoma lanigera Verrill, Pract. Ent. I, p. 21, 1865.
Eriosoma pyri Riley, Ins. Mo. I, p. 118, 1869.
Schizoneura lanigera Lowe, Ann. Rep. N. Y. Exp. Sta., for 1896, p. 570.
Schizoneura lanigera Marlatt, Circ. 20, Second Ser., Div. of Ent., 1897.
Schizoneura lanigera Garman, Bull. 80, Ky. Exp. Sta., p. 208, 1899.
Schizoneura lanigera Alwood, Spec. Bull. (C. P. C. 45), Va. E. S., 1904.
Schizoneura lanigera Smith, R. I., Bull 23, Ga. State Board of Ent., 1907.

In the warmer fruit growing sections of Colorado this louse lives over winter regularly upon the trunks and limbs as well as on the roots of the trees. Upon the roots it lives in all stages of growth, but upon the top all the lice die except the last brood born in the fall. These leave the places of their birth before molting, and apparently without feeding or growing, to hunt a hiding place that will give them protection for the winter. The hiding places are beneath the dead bodies of the partly or fully grown lice (which all die from the cold), beneath scales of the bark, or about the crown of the tree between the bark and loose dirt. These over-winter lice do not secrete any cottony covering until they begin to feed and grow the following spring. In this respect the woolly aphis has a habit similar to *Chermes coweni*, the last brood of which (var. *coweni*) rest upon the leaves of the red spruce, or *cooleyi* on the bark of the blue spruce, without growing or secreting a covering of wax threads from the late summer until they are warmed into activity the following spring. Plate 5, fig. 11, was drawn from one of these over winter young after it had begun to grow in the spring, so it is a little too light in color and a trifle broad across the abdomen for the typical over-winter condition.

We have had no trouble to get the alate females to deposit the true sexual forms in confinement. We have been utterly unable to keep these alate females upon the apple trees to deposit their young. They seem possessed of [illegible] to get away from the tree,

so that the sexual forms have always been deposited upon the walls of the breeding cages.[1]

NATURAL ENEMIES

The most active natural enemies of the woolly aphis in Colorado have been predaceous insects. We have reared no parasite from it, but, Aug. 21, 1908, Mr. L. C. Bragg brought into my office a female *Aphelinus mali*[2] busily ovipositing in apterous females of this louse. Among the Coccinellids, *Hippodamia convergens* is by far the most abundant destroyer of this louse both upon the eastern and western slopes of the mountains. Mr. E. P. Taylor also took *H. sinuata, Coccinella 9-notata, C. monticola* and *C. transversalis* feeding on this louse in the orchards about Grand Junction, and we have noted *H. transversalis, C. 9-notata, C. monticola, C. frigida,* and *C. 5-notata* (*transversalis* and *transversoguttata*) feeding upon it in eastern Colorado.

Mr. Taylor also reared two syrphus flies at Grand Junction on this louse, namely, *Catabomba pyrastri* Linn. and *Eupeodes volucris* O. S.

Lace-wing flies (Plate 5, figs. 15 and 16) are also very destructive to *Schizoneura lanigera* in Colorado, and especially upon the western slope in the Grand Valley, where Mr. Taylor concluded that they did more than all else to subdue the unusually severe outbreak of this louse in that valley during the early summer of 1907. The Capsid, *Camptobrochus nebulosus* Uhl, we have found a common feeder upon this and some other plant lice in Colorado.

Alate Female—Plate 5, fig. 10.

General color nearly black to naked eye, but the abdomen is really a dark yellowish or rusty brown. Leg, eyes and antennæ are black or blackish, proximal ends of femora and tibiæ may be yellowish, nerves of wings black, the subcostal being very heavy, and the stigma dusky brown to the naked eye, but really a dark green. Third cubital vein sub-obsolete half way to the fork. Cauda and cornicles nearly obsolete.

The yellowish brown color of the abdomen is due mainly to the female embryos showing through, the two sexes being present in about equal numbers, usually four or five of each, but the numbers may vary from three to six. Sixteen winged females dissected gave a total of 66 females and 48 males. Joints three to six of the antennæ are strongly annulate, as shown in Plate 6.

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[1] Since writing the above, I have succeeded in obtaining numerous examples of light orange yellow sexual females and the smaller dusky brown males, and a few yellow eggs upon leaves and bark of twigs that had been inclosed six weeks before in small cheese cloth sacks in the orchard. The first egg was obtained Sept. 18, at Ft. Collins, Colorado.

[2] Determined for me by Dr. L. O. Howard.

fig. 19. Length of body, 2.20 mm.; wing, 2.80 mm.; antenna, .80 mm.; joints: three, .40 mm.; four, .12 mm.; five, .13 mm.; six, .07 mm.; joint three with about 21 annulations; four with 3 or 4; five with about 5, and six with 1 or 2, or none.

The sexual females are brown ochre in color; the males are dark green, or a greenish brown; both sexes without beaks.

Over Winter Young—Plate 5, fig. 11.

The following description is from specimens brought from Delta, Colorado, where they were taken March 28, 1908:

General color a dingy yellowish brown, the head and prothorax being darker, and in some specimens almost black, the head being the darkest part. The antennæ, legs and the distal end of the beak are dusky brown. Length of body, .65 mm. to .75 mm.; the width, .35 mm.; length of body to the end of the beak, which projects caudad some distance beyond the abdomen, is .77 mm.; antenna five-jointed and .27 in length, rather stout and set with a few stout hairs. There are very few hairs over the body. There is some variation in the general color, some specimens being considerable darker than others. As soon as these little lice begin to feed, the color of the abdomen becomes much lighter. A pair of hairs arising at the bases of the tarsal claws of each foot are slightly knobbed at the distal ends.

The European Grain Aphis, *Aphis*[1] *avenae* Fab., the Clover Aphis, *A. bakeri* Cowen, the Rosy Apple Aphis, *A. pyri* Boyer, and the Sweet Clover Aphis, *A. medicaginis* Koch, all occur to some extent in Colorado apple orchards. A discussion of these species is deferred for a later number of the JOURNAL.

APHIDS INFESTING THE PEACH

The Black Peach Aphis, *Aphis persicae-niger* Smith; Plate 5, figs. 12, 13, 14.

Some of the More Important Literature

Aphis persicæ-niger n. sp. Smith, E. F., Ent. Amer. 1890, pp. 101, 201.

Aphis persicæ-niger Smith, J. B., N. J. Exp. Sta., Bull. 72, 1890.

Aphis persicæ niger Johnson, Md. Exp. Sta., Bull. 55, 1898.

Aphis persicæ niger Froggart, Miscel. Pub. No. 760, Agrl. Gaz. N. S. W., 1904

This louse occurs in a few orchards only in Fremont, Delta and Mesa counties. Early in the spring it attacks the tender bark of small limbs and sprouts and often becomes quite numerous before any of the buds open. We have searched in vain for males, sexual females or eggs of this louse.

[1] This louse seems to me to fall readily into the genus *Aphis*. It does not have the very long clavate cornicles characteristic of Passerini's genus *Siphocoryne*. According to Schouten and Kirkaldy *Siphocoryne* becomes a synonym of *Hyadaphis* Kirkaldy. See Mem., Soc. Entom. Belgium, XII, p. 229.

Adult Apterous Females—Plate 5, fig. 12.

When fully mature these females appear deep shining black, but under a hand lens the margins of the abdomen, the thorax and the basal portions of the antennæ are more or less yellowish or amber brown in color. The legs are dusky yellow with distal ends of tibiæ and tarsi black; cornicles black; cauda dusky brown to blackish, hardly distinguishable; cornicles straight, enlarged slightly towards the base, and with distinct flange at tip. The general shape of the body is very broad for the length, especially in the older individuals. These females are not black until after the final molt. During the nymph stages they vary from very pale to rather dark yellowish brown.

Newly Born, Viviparous Females—Plate 5, fig. 13.

When first born the young lice are very pale, almost a lemon-yellow in color, becoming darker as they grow; eyes dark red; antennæ, cornicles and feet a little dusky. When ready to molt they measure about .70 mm. Cornicles short, stout and with a wide flange; beak extending to a point half way between hind coxæ and tip of abdomen. Length of antenna, .35 to .50 mm.; joints one and two, short, cylindrical, joint one being much the thicker, joint three about as long as one and two together; joint four short, but little longer than two, and with a sensorium at distal end; joint five a trifle longer than four, stout, and with a cluster of sensoria at the distal end; joint six is long spindle-shaped and is about equal to three and four together; division between three and four sometimes wanting.

After first molt the lice become darker, a good salmon color, and measure from 1 to 1.40 mm. in length; antennæ 7-jointed and about two-thirds the length of the body, distal half blackish, cornicles equaling tarsi in length, broad at base and with wide flange.

Winged Viviparous Female—Plate 5, fig. 14; and Plate 6, fig. 7.

General color of body deep shining black; bases of femora, tibiæ, cauda and usually the eighth abdominal segment in front of it, yellowish. No lateral tubercles upon prothorax or abdomen, middle ocellus rather prominent, antennæ upon slight tubercles. Length of body about 1.75 mm.; antenna, 1.80 mm.; cornicles, .23 mm.; the cornicles are a little stouter at base and have a moderate flange; length of wing, 3 mm.; stigma yellowish; venation normal; joints of antenna about as follows: three, .46 mm.; four, .31 mm.; five, .21 mm.; six, .11 mm.; seven, .55 mm.; cauda very small, hardly longer than broad at base; joints three and four of antenna strongly tuberculate with many sensoria, and joint 5 with 2 to 6 similar sensoria (Plate 6, fig. 7).

(*Continued in next number.*)

EXPLANATIONS OF PLATES

PLATE 5: Figs. 1 to 8, *Aphis pomi;* 1, stem-mother, first instar; 2, adult stem-mother; 3, apterous viviparous female of the second generation; 4, young, first instar, second generation; 5, winged viviparous female of second generation; 6, pupa of third generation; 7, adult male; 8, adult oviparous female. *Schizoneura lanigera*—9 and 10, apterous and alate viviparous females; 11, the small over-winter form. *Aphis persicæ-niger*—12 and 14, adult apterous and alate viviparous females; 13, young viviparous female, first instar; 15, *Chrysopa* sp. and eggs; 16, *Chrysopa* cocoon. The enlargement in each case is marked beneath the figure. This plate is from Bull. 133, Colo. Exp. Sta., by Gillette and Taylor, M. A. Palmer, artist.

PLATE 6: Antennae, tibiae and cornicles of *Aphis pomi*, 1 to 6; *Aphis persicae-niger*, 7; *Myzus cerasi*, 8; *Myzus persicae*, 9–17; *Schizoneura lanigera*, 18–19; egg shell of *Aphis pomi*, 20. Enlarged 80 diameters in each case, except the shell, which is enlarged 20 diameters. This plate is a modification of Plate IV, Bull. 133, Colo. Exp. Sta., by Gillette and Taylor. M. A. Palmer, artist.

SAW FLY LARVAE IN APPLES

By R. L. Webster, *Ames, Iowa*

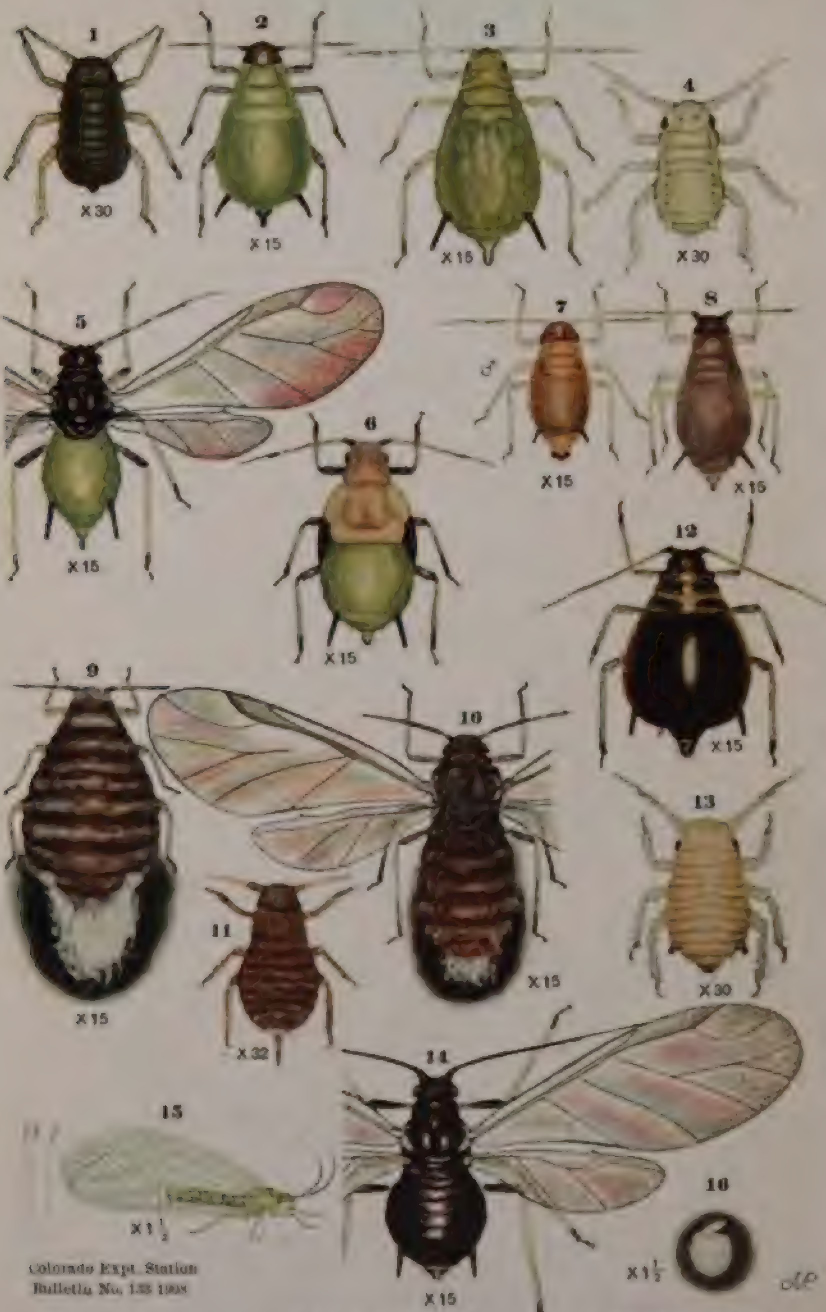
The saw fly, *Taxonus nigrisoma* Nort., sometimes called the "Dock False-worm," has been reported several times as eating into apples. Doctor Fletcher and Professor Lochhead have already noted this rather peculiar habit, so that it is by no means unknown. Three years ago I found several saw fly larvae in Greening apples, which larvae turned out to be the above species. The apples were shipped from New York state and were kept in the cellar at my home during the winter. The larvae were studied in the entomological laboratory at the University of Illinois in March and April, 1905.

The burrow containing the larva extended about half the distance from the skin to the core of the apple. From the exterior the burrow was characterized by a circular, brownish, discolored patch, in the center of which was the small hole made by the larva when entering the apple. The burrow was considerably larger in diameter than the larva itself, and the larva was partially curled up within. None had pupated when they were found early in March.

On March 7th several larvae were placed in a breeding cage in the laboratory. Small holes were made in the apples, to serve as burrows. The larvae, however, would not remain in these holes, but pupated, without forming a cocoon, on the damp sand of the breeding cage. Larvae pupated on the 27th and 29th of March in the laboratory, and the adults emerged the 1st and 3d of April. The average length of the pupal stage was 5.6 days.

Chittenden and Titus have already given an excellent description of the larva in Bulletin 54 of the Bureau of Entomology, so that it is unnecessary to give it here.

About the same time Prof. E. S. G. Titus, then connected with the Bureau of Entomology at Washington, reared this species in the insectary there, from an apple purchased by Mr. Coulen in Washington. The adults reared from the apple in Illinois were sent to Professor Titus and were pronounced to be the same species, *Taxonus nigrisoma* Nort.

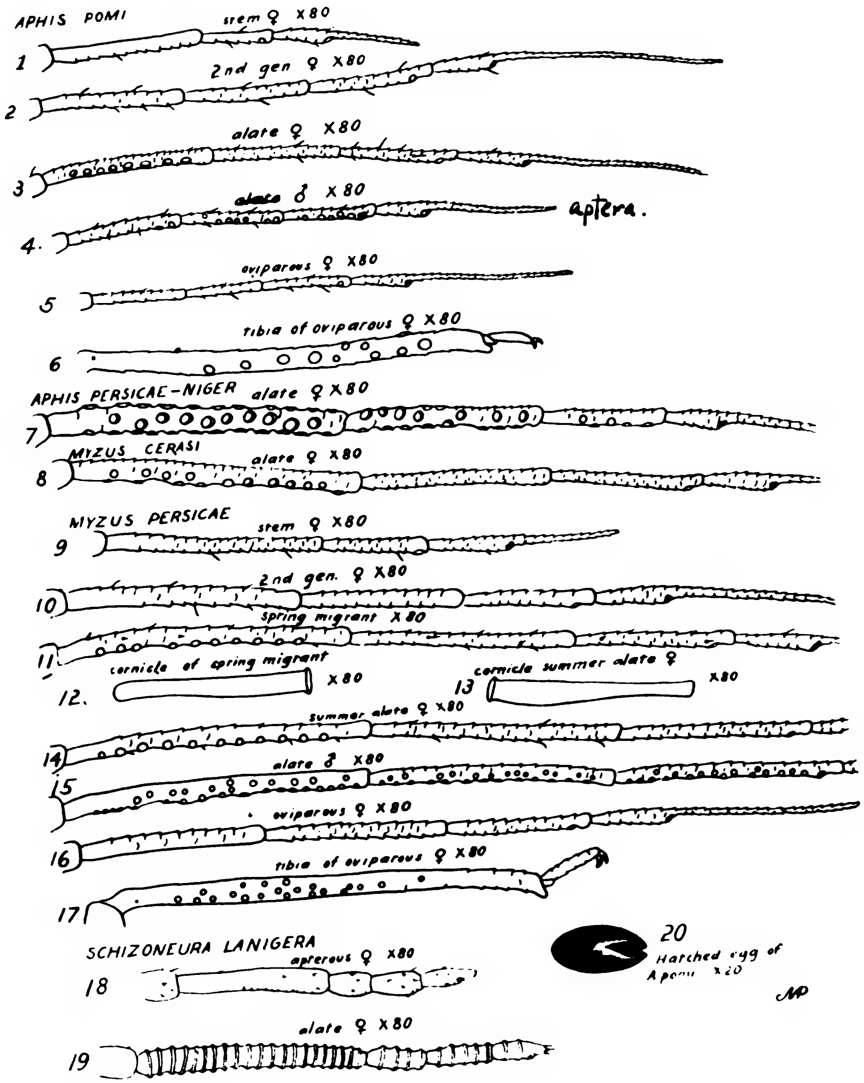


Colorado Expt. Station
Bulletin No. 133 1908

PLATE I

PLANT LICE

MATTHEWS-NORTHRUP CO.
BUFFALO



Pl. 1A Col. Exp. Sta.
Bull. 133.

The natural food plants of this saw fly seem to be *Rumex* and *Polygonum*, and the usual place of pupation is in the stalks of those plants. According to J. G. Jack, however, the larvæ will even bore into some substance such as partially decayed wood to pupate. If such is the case, apples fallen to the ground, or even apples stored in any place in the vicinity of dock or *Polygonum* infested with this larva, would offer an excellent situation for its hibernation. No doubt the insect could easily be controlled, if it should happen to become noxious, by getting rid of the natural food plants.

NOTES ON MAPLE MITES

By P. J. Parrott

Our native Eriophyidæ have received very little attention among entomologists, so that comparatively little is known of the species that exist in the United States. The studies that have been made on this group of mites have largely been confined to a few species attacking fruit and shade trees, and much of the literature dealing with them consists of mere records of the various species and their respective host plants. In the recent catalog of Acarina of the United States, by Nathan Banks, twenty-seven species were listed which were divided among the genera *Eriophyes, Phyllocoptes, Epitrimerus* and *Cecidobia.* Dr. Alfred Nalepa in his excellent treatise on European Eriophyidæ (Das Tierreich, Lief 4, Eriophyidæ) has enumerated 226 species, distributed among nine genera. With the great diversity of our flora there is evidently a large field for study on this family of mites in this country.

The probable variety and numbers of these interesting creatures has recently been indicated to us in our investigations on the species thriving on maples. In the studies on the mites existing on the foliage of the Silver Maple, *Acer saccharinum* L., Sugar Maple, *Acer saccharum* Marsh, Red Maple, *Acer rubrum* L., Box Elder, *Acer negundo* L., and the Norway Maple, *Acer platanoides* L., fifteen species have been recognized. Among these there were two old world species, *Phyllocoptes gymnaspis* Nal. and the remarkable *Oxypleurites serratus* Nal. collected from the Norway Maple, which are recorded for the first time in this country. This is nearly twice the number of mites recorded on maples abroad and the list of our native species will undoubtedly be further increased as studies are made on other varieties of maples.

The interest of our entomologists in the maple mites is largely con-

fined to the two common and widely distributed species on the Hard and Soft Maples, which are generally known as the Fusiform Maple Gall, *Eriophyes acericola* Garman, and the Bladder Maple Gall, *Eriophyes quadripes* Shimer. Both of these are typical *Phyllocoptes*, and for the sake of stability of nomenclature should hereafter be referred to respectively as *Phyllocoptes aceris-crumena* Riley and *Phyllocoptes quadripes* Shimer.

Descriptions of the Hard and Soft Maple Gall Mites

Previous descriptions of both these species are too meager to distinguish them from associated mites. They may be recognized by the following more important characters:

Phyllocoptes aceris-crumena Riley.

Body broadest at the posterior margin of the thoracic shield, with the abdomen gently acuminate. The thoracic shield is broad, with the lateral angles and the anterior margin gently rounded. It does not project over the body. The dorsal setæ are short and are situated near the posterior margin of the shield. The legs are of medium size and the feathered hair has four rays. The thoracic setæ are all present. The first pair are short and fine. The second pair are of medium length, while the third pair are rather stout and of medium length.

The striæ on dorsum of abdomen are coarse and number from 30 to 32, while the striæ on ventrum are much narrower, with fine punctuation in between, and are about 60 in number. The lateral and genital setæ are short. The caudal setæ are long and stout. The accessory setæ are wanting. The first pair of ventral setæ are long; the second pair of ventral setæ are short, while the third pair are very long. The females measure about 170 microns in length and about 60 microns in width.

Phyllocoptes quadripes Shimer.

The anterior portion of the body is wide with the abdomen rather abruptly acuminate. The mites vary in color from white, with pinkish reflections, to a salmon color for the adults and hibernating forms. The thoracic shield is broad and is slightly wider than long. The lateral angles are gently rounded. The anterior margin is gently rounded and slightly projecting, but does not extend over head. The dorsal setæ are short and stout. They are broadly separated and are situated on the posterior margin of the shield, projecting over the first four striæ of the abdomen. The rostrum is large and is broad at the base. The sternum is slightly furcated. The first pair of thoracic setæ are short; the second pair of thoracic setæ are of medium length, while the third pair are long. The legs are of medium length and have the usual spines. The feathered hair has four rays. The claw is a little longer than the feathered hair and is slightly knobbed. The spine on segment three is rather stout and reaches to the feathered hair. The epigynium is of medium size and bears on its lateral margins one pair of setæ, which are short and fine. The epiandrium is arched in shape.

The abdomen has from 37 to 40 coarse striæ on dorsum and from 60 to 65 fine striæ on ventrum. The first pair of ventral setæ are long and stout, and reach to the base of the second pair of ventral setæ. The second pair of

ventral setæ are small and fine. The third pair of ventral setæ are long and stout. The caudal setæ are of medium length. The accessory setæ are not present. The females measure from 180 to 220 microns long, while the males average about 170 microns in length.

The Hibernation of the Mites

Many species of mites hibernate under the bud scales, but the location of the winter quarters of these two species seems not to have been determined. While occasionally a specimen may be found in hiding under a bud scale, the buds generally harbor only a very few, which represent but an exceedingly small fraction of the mites that have been produced for that season on the tree. Shimer (Trans. Amer. Entom. Soc. II, 1869, p. 319) suggested that it is probable that they pass the winter, perhaps in the egg stage, on the ground around the tree and in early spring ascend the trunk. Our observations on the hibernating habits of these mites (*P. quadripes* and *P. aceris-crumena*) show that they seek protection just under the loose edges of bark, about the stubbed ends of broken twigs and limbs and about scars of wounds caused by hail and other agencies. For the past two years the beginning of the migration of these mites from the leaves to hibernating quarters occurred on July 12 and 10 respectively. On badly infested trees the mites have been seen assembled in such large numbers on portions of the tree as to give a very distinct reddish tinge to the bark. The mites are only to be found in scattering numbers on the trunks of the trees near the ground. If it should become desirable to spray for these mites, protection could unquestionably be obtained, by the thorough treatment of the trees with an efficient contact insecticide when the mites are migrating in their largest numbers on the bark, or when they are established in their winter quarters.

NOTES FROM CONNECTICUT

By W. E. Britton, *New Haven, Conn.*

The fall canker worm, *Alsophila pometaria* Harris, has caused more damage in various portions of the state than for several years. Apple orchards in the vicinity of Stamford, in Madison, and in Stonington, have been stripped and presented a brown appearance by the middle of June. These orchards, of course, received no spraying or other treatment to destroy the insect. Not only have the apple trees been damaged, but many other kinds of shade and woodland trees have also been more or less injured by the canker worms. Elm trees in

New Haven were in some cases almost defoliated, and the larvæ were observed feeding upon maple, chestnut and hickory. A hedge of California privet was badly eaten, and oak trees at Stonington were partially defoliated. At Old Saybrook the elms were considerably injured last year, and the local village improvement society banded a large proportion of the trees, which are old and large ones, but the sticky bands were not placed upon the trees until after many of the eggs had been laid, as it was supposed that the spring species, *Paleacrita vernata* Peck, was responsible for the injury. Though both species were present, the fall canker worm was far more abundant than the spring species, and doubtless caused a like proportion of damage.

A resident of Stonington, noticing the brown appearance of an apple orchard, inquired if it was the work of the gypsy moth, which is in that vicinity, as he had seen the men working to combat it. Another remarked that we might better stop the gypsy moth work and direct our efforts toward controlling the canker worm, as the latter seemed to be doing more damage. In this region last year a similar remark was made regarding the rose chafer. As a matter of fact, the gypsy moth, which is known to be present in Connecticut only at Stonington, where it infests not more than one square mile of territory, has not been sufficiently abundant there to defoliate trees so as to be noticed by the people. Many know of its presence simply by hearing of it and by seeing the force of men at work. If its presence had not been discovered, however, or if no attempt had been made to control it, doubtless by this time it would have become so abundant as to attract attention. At present about ten men are at work, 14,000 trees have been banded and something over 1,000 caterpillars have been destroyed this season, in spite of the extremely careful search for egg-masses last winter by both state and government scouts, some of the ground being covered several times. Every effort is being made to exterminate this colony, and though much scouting has been done in other parts of the state, especially along the principal highways, no gypsy moths have been found elsewhere.

The peach sawfly, *Pamphilius persicum* MacGillivray, which was so abundant in the orchards of Barnes Brothers, Yalesville, last year, was greatly reduced in numbers by spraying with lead arsenate. The owners sprayed between 4,000 and 5,000 peach trees during the last of June and the first week in July, using from two to three pounds of the poison to fifty gallons of water. An examination of the sprayed trees June 25 showed practically no damage by the insect this year, only an occasional leaf being eaten. In an unsprayed portion of the orchard some distance removed, the larvæ were much more abundant,

and some of the trees were from one fourth to one half defoliated. No spraying has been done this year, but the owners are ready to begin whenever the occasion seems to warrant the outlay. The larvæ observed were mostly on the shoots in the center of the tree, and here the leaves were badly eaten when those at the ends of the branches were untouched. Several other orchards in New Haven County have been examined for the sawfly and though traces of it have been found nearly everywhere, in no case has it been so abundant as it was last year in the Barnes orchard, and I doubt if any spraying will be done to check it this year.

I will here mention a point of considerable interest regarding this species. Doctor MacGillivray described the insect as a new species, but from the manner in which it appeared suddenly as a pest, some of us felt that it might have been introduced. During April Mr. S. A. Rohwer of Boulder, Col., wrote me for specimens, stating that he was specializing on the sawflies. Specimens of both sexes were sent, and these he acknowledged April 28th, and his letter contained the following paragraph:

"In a collection of sawflies which I am naming for the University of Nebraska, I find two specimens of *P. persicum,* taken June, 1903, at West Point, Nebraska. This is rather surprising! It seems to bear out the idea that this pest is a native one."

If the peach sawfly is a native species and occurs in Connecticut and Nebraska, we should expect to find it in other states, and collectors should be on the watch for it. After many observations have been made we shall be better qualified to pass judgment regarding its origin as a pest in this country. The distribution of this insect is certainly an interesting subject.

FACTORS CONTROLLING PARASITISM WITH SPECIAL REFERENCE TO THE COTTON BOLL WEEVIL

By W. Dwight Pierce, *Bureau of Entomology, U. S. Dept. of Agriculture*

It is well understood that the relationships of parasites and hosts are so intimate, and so delicately balanced, that any factor which modifies in any manner the welfare of either species, at the same time reacts on the other species. Consequently, in the case of economic application of parasite control, the worker cannot afford to overlook any aspect in the status or biology of either host or parasite, or of

any other insect, the biology of which may come in contact with that of either species, directly or indirectly.

A recent excellent review of the economic application of entomophagous insects, by Marchal,[1] contains remarks upon eight factors which may influence or control the amount of parasitism by a given species upon a given host. In studying this paper rather carefully I found that several factors which are important in the boll weevil problem, were not considered. With this in view the following notes, mainly on weevil parasites, have been compiled. Twenty-four factors have here been selected as distinct and of sufficient importance for individual mention. These factors are grouped in three divisions. The following were suggested by Marchal: relative fecundity, hyperparasites, co-parasites, other plant-feeding insects, birds and other vertebrate enemies of insects, climate, rapidity in sequence of generations, and retardation of development. Prof. C. W. Woodworth personally suggested the discussion of premature death, fungus diseases, and duplicated mortality. All of the factors have probably received more or less individual mention, but the grouping in this paper and the illustrations are original.

I. Biological Factors Involving Only Host and Parasite

1. *Relative fecundity of host and parasite.* In attempting to utilize parasites or other entomophagous insects, the investigator should always give the advantage of his efforts to the species surpassing, or most nearly approaching the fecundity of the host. For it is very evident that the species having the greatest number of offspring, all other factors being equal, has the advantage.

The relative fecundity is so important that it requires special attention before an extensive economic application is attempted. Not only the total number of eggs laid by each species, but also the period of oviposition should be ascertained if possible. Many species are able to protract considerably the oviposition period, and thus a host might easily gain the advantage over a one-generation parasite. It is not sufficient to ascertain these points for only a portion of the year, because of the varying length of the oviposition period and even of fecundity, due to climatic influences. This may best be illustrated by reference to the studies of Hunter and Hooker[2] on the cattle tick,

[1] "The utilization of auxiliary entomophagous insects in the struggle against insects injurious to agriculture," by Dr. Paul Marchal. Ann. Nat. Agr. Inst., 2d ser., vol. VI, part II, Paris, 1907, pp. 281 354; translated, Popular Science Monthly, April, May, 1908, pp. 352 370, 406-419.

[2] Bureau of Entomology, Bulletin 72.

Margaropus annulatus Say, in which the oviposition period is shown to range from eight days in summer to forty-two days in winter.

2. *Relative rapidity of development.* A host which passes through its developmental period more rapidly than any of its parasites has the greatest chance for safety, and conversely, the parasite with the most rapid development must be considered first in a scheme of parasite utilization. The development of the boll weevil may be best illustrated by a curve which shows 38 days from oviposition in April as necessary before maturity, 13 days in July, and 30 days in October. The development of *Bracon mellitor* Say beginning in June takes about 25 days, in July and August 10–18 days, in late October 175 days. A similar curve may be plotted for each of the five other important species.

Among one-generation weevils, *Lixus musculus* Say may be contrasted with *Desmoris scapalis* Lec. The former completes its development in the fall and hibernates as an adult, but its principal parasite, *Glyptomorpha rugator* Say seldom matures until the following spring. The Desmoris takes about ten months to develop, and yet it is parasitized by *Bracon mellitor*, which develops in mid-summer in 15 days, and is hence capable of breeding several generations at the expense of the more retarded individuals of the Desmoris.

3. *Relative rapidity in sequence of generations.* An instance of greater rapidity in sequence of generations in parasite than in host has just been cited. In the case of the boll weevil and most of its parasites a rapid sequence of generations takes place, but at practically the same rate. There is a notable exception in the cases of the two species of Pediculoides, which attack the weevil. These species reproduce at the rate of a new generation every four days. If other factors did not interfere, the mites could become very efficient enemies of the boll weevil.

4. *Retardation of development.* It is very common among insects for some individuals to develop more slowly than others of the same age. There are many causes for this phenomenon, among which may be classed the character of the food supply. The boll weevil breeds both in squares and bolls, but the development in the latter is much more retarded than in the former. If a cold spell finds immature stages of the boll weevil in dry bolls, the development may be retarded and prolonged until the following spring, but if the individuals are in squares at this time, they will more than likely mature under the heat of the sunshine in the succeeding warm spell and hibernate as adults.

When the parasite species has a short period of activity, this char-

acteristic would tend to increase the chances of the host species. The phenomenon of retarded development is often observed also in parasite species. Entomologists may take advantage of this factor by refrigeration of immature parasites until they are needed for work.

5. *Possible parasites per host.* A host may support one or many parasite individuals at a time. When a parasite places a single egg in a very young host and that egg subdivides as the host grows, sometimes forming a sufficient number of parasites to entirely consume the host, the case is designated as polyembryony. This property is suspected as occurring in Tetrastichus on *Orthoris crotchii* Lec., and in several species of Horismenus which attack bruchids and Lixus.

The boll weevil is seldom capable of furnishing food for more than one parasite, although sometimes two are bred. On the other hand none of the boll weevil parasites are able to recognize the existence of another parasite egg or larva upon a prospective host. In fields where the percentage of parasitism has reached a very high point, such evidences of duplication are very numerous. In one instance thirteen eggs of a single species were found on one larva, although only one could possibly mature, cannibalism settling the fate of the rest.

A very striking example is presented by Pediculoides. If a single mite finds a weevil larva, two generations of its offspring can be bred on the original host; in the case of wasp larvæ, even more generations may be reared.

6. *Proportion of sexes.* In computing the possible gains of parasite over host, a very important consideration is the proportion of sexes in the two species. The most striking phenomenon in sexual relationships is of course parthenogenesis, which is supposed to occur with many parasite species, and among hosts is most prominent in the aphids.

In Pediculoides males and females born ovoviviparously from the same parent, mate upon the body of the parent, after which the males die.

Large series of examinations in the boll weevil problem have shown the following percentages of males: the host, *Anthonomus grandis*, has 58 per cent of males, *Bracon mellitor* Say 39 per cent, *Catolaccus hunteri* Cwfd. 22.8 per cent, *Cerambycobius cyaniceps* Ashm. 26.7 per cent, *Eurytoma tylodermatis* Ashm. 35.4 per cent, *Microdontomerus anthonomi* Cwfd. 15.3 per cent. The last named species has shown the most remarkable gains.

7. *Condition of host.* When the parasite species requires a certain stage of the host for attack, its activity is sharply limited. This lim-

itation is greatest in egg parasites, especially when the eggs are laid separately, less so when they are in clusters. Parasites which attack adults are not as a rule very numerous, although occasionally recorded. The hymenopterous parasites of the boll weevil will attack either larva or pupa, although *Bracon mellitor* generally attacks the younger larvæ. By this habit, this species frequently loses some of its value through accidental secondary parasitism by other species.

8. *Dissemination.* A migratory host species may frequently remove itself many miles from its hereditary enemies by rising in flight. The boll weevils disperse in all directions in the fall of each year, being capable of moving fifty to a hundred or more miles. It is not probable that the parasites can do this, because at present they are known to be more or less limited in their distribution. Some of these parasites certainly can not keep up with such a spread. On the other hand, a migratory host may carry its parasites, as *Toxoptera graminum* Rond. spreads its parasite *Lysiphlebus tritici* Ashm.[1]

9. *Adaptation to new climates.* In the event of a dispersion by either host or parasite, or of an accidental or intentional introduction of either species, it is of course necessary to understand the ability of the species to accommodate itself to the new conditions of weather and perhaps even of food. Although it is a very adaptable species, the boll weevil frequently loses a good part of the territory gained by the last dispersion of the year.

10. *Adaptability to changed food supply.* When the food-plant of a one-plant species, or the host of a one-host parasite, is checked by any agency, a corresponding check is immediately placed upon that insect also. Therefore, when either the host or parasite is thus restricted and the other is capable of adjusting itself to other food-supply, a decided advantage exists in favor of the adjustable species. The boll weevil is absolutely confined to one species of host-plant, but its parasites without exception are able to propagate on several other species of weevils. I have previously called attention to a sudden adaptation of *Cerambycobius cushmani* Cwfd., to the boll weevil, because of the absence of its original host; of *Eurytoma tylodermatis* Ashm., because of the cutting of weeds containing its host; and to the rapid adaptation of *Microdontomerus anthonomi* Cwfd., which in two years has become the predominant boll weevil parasite in certain portions of central Texas.[2]

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[1]Webster, F. M., 1907. The spring grain-aphis, or so-called "green bug." U. S. D. A., Bureau of Ent., Circular 93, p. 15.

[2]The economic bearing of recent studies of the parasites of the cotton boll weevil. Jour. Econ. Ent., Vol. 1, pp. 117–122.

11. *Aestivation and hibernation.* The varying conditions of food supply or species habit, which render a resting period imperative, bring about a factor of extreme variation. With the boll weevil the entrance into hibernation in a given locality may extend over two months in the fall, and the emergence frequently lasts from March to July. Even though a parasite species should carry off all of the developing weevil offspring of the earliest weevils, there would still be many more weevils in hibernation, to continue the species.

12. *Endo- and ecto-parasitism.* Although a minor factor, still the location of attack by a parasite must be taken into consideration. *Zygobaris xanthoxyli* Pierce breeds in the berries of *Xanthoxylum clavaherculis*, and pupates in the ground. It is parasitized internally by *Sigalphus zygobaridis* Cwfd., which does not kill it until the earthen pupal cell is formed. Thus the host prepares a safe retreat for its parasite. The weevil is also parasitized externally by *Catolaccus hunteri* Cwfd., which kills the host larva while it is still in the berry. This instance will suggest how this factor may be important.

13. *Premature death.* In considering the numerical ratio between two species, there should be prepared data to show the percentage of each species which die before fulfilling their sexual functions.

II. Other Biological Factors

1. *Insectivorous vertebrates.* Insects have many enemies among the vertebrates, such as batrachians, reptiles, birds, and mammals, which show very little discrimination between hosts and parasites. Parasitized insects, being uneasy or frantic in their movements, are more open to attack by birds than healthy individuals.

2. *Other plant feeding insects.* The existence of other plant-feeders on the same host plant is an element which has a direct bearing upon the status of the given insect. For example the cotton squares and bolls are bored by the boll weevil, the boll worm, several square borers, such as Calycopis and Uranotes, and even by the leaf worm. The activity of any of these Lepidoptera in squares necessarily cuts down the food supply of the boll weevil. When the leaf worms defoliate the cotton, they stop its growth, eliminate the weevil's food supply, and remove the shelter from the sun, with the result that the survivors must disperse. An extended region of defoliation may cause the starvation of multitudes of flying weevils in search of fresh fields. Finally, the limiting of the food supply and the offspring of the weevils limits the parasites, while the work of the sun made possible by defoliation forestalls them, and the dispersion leaves them still less of a chance for great multiplication. Other examples

of this class may be given. *Anthonomus squamosus* Lec. breeds in the heads of *Grindelia squarrosa,* which heads are frequently entirely riddled by a large noctuid caterpillar, *Lygranthoecia mortua* Grote, at the expense of the developing weevil. This same noctuid consumes the larvæ of *Desmoris scapalis* Lec. in the heads of *Sideranthus rubiginosus,* after the same manner. *Lixus musculus* Say breeds in stem galls of *Polygonum pennsylvanicum,* but is frequently in the path of a stem mining pyralid, which invariably consumes the weevil stage or its parasites. Any such interference with the host insect, of course, affects the welfare of its parasite species.

3. *Predatory insects.* With certain striking exceptions predatory insects do not show much discrimination between insects which might become their prey. The most valuable of all predators are probably the ants. In fact in the boll weevil problem they rank very high as an element of control. Ants carry away every vestige of insect matter from the cell. They may devour larvæ killed by heat or parasites. There is a question therefore as to the mortality to be accredited to them, since some portion might have been accomplished by heat or by parasites. The problem of utilizing ants is as complicated as that of utilizing true parasites, because of the social economy of these insects.

4. *Hyperparasites.* The existence of hyperparasites is always very provoking when the question of controlling an injurious insect is to be solved. Before utilizing the primary parasites the worker must attempt to eliminate the secondary parasites. The entire effectiveness of a given parasite may be destroyed by its hyperparasites, and again these may be almost completely checked by tertiary parasites, and they by quaternary species. Still more provoking are the many cases of species which act according to conditions as primary and secondary, also even tertiary, or as secondary, tertiary, and quaternary, as shown by Howard, Fiske, Silvestri and others. Accidental secondary parasitism, or that phase which is rendered so by the priority of another individual, occurs in the habits of Cerambycobius, Eurytoma, and Microdontomerus on the boll weevil. Frequently the eggs of three species are found on a single weevil larva. Thus it may be seen how the several co-parasites of an insect, although all working to the same end may frequently work at cross purposes, by each destroying some of the others.

5. *Co-hosts.* The subject of co-hosts has received little attention in the past. Not only do phytophagous insects frequently have many host-plants, but it is also common for parasites to attack numerous closely related species, or insects with similar habits. In considering

the inter-relationships between a given host and a given parasite, it must be remembered that this relationship is intimately connected with the status of all the host-insects or host-plants of the given host, and with all the co-hosts of the given parasite, and all of the host-plants or host-insects of these co-hosts. Thus in the boll weevil problem the weevil has only one food plant to be considered, but it has twenty-three primary parasites, three of which are sometimes accidentally supernumerary; also seven predators, which attack the boll weevil or its parasites. Two parasites are known to attack these predators. Forty-one weevils are known to serve as co-hosts of the primary parasites, some of them harboring three or four species. Twenty-one parasites, unknown to the boll weevil, attack these co-host weevils. Ninety species of plants are known to serve as hosts to the forty-one co-host weevils. The relationships do not stop here, for we know other weevil hosts of the co-parasites of the co-hosts, and also other parasites to these weevils, and finally hyperparasites on some of these parasites.

6. *Fungous and bacterial diseases.* Although very little is known of the diseases of insects, the fact remains that many are carried off by this factor.

III. General Factors of Control

1. *Climate.* Above all other factors and holding a definite relationship to each, stands climate. As an agency of mortality it displays its powers in many different manners. Frosts, rains, droughts, sunshine, shade, floods, storms and winds may be fatal, under the proper conditions. That these factors do not influence different species in the same manner is well known. The boll weevil is easily killed by the direct rays of the sun falling upon it, or upon the square containing it, when the air temperature is in the nineties. The parasites are not so easily affected. A frost in November, 1907, killed fifty-five per cent of the weevil stages, but had no apparent effect upon the parasite stages present. The relative fecundity, length of oviposition period, rapidity of development, rapidity in sequence of generations, proportion of sexes, dissemination, and aestivation or hibernation are directly controlled by climatic conditions, and more or less arbitrary formulae may be worked out after much study to represent each relationship. At the same time every plant and animal species involved in the given problem is directly controlled by the same conditions.

2. *Plant conditions.* The condition of the host-plant may very greatly influence the given problem. For instance, it frequently happens that the cotton plant fails to form a complete absciss layer beneath an injured square or boll, and this injured part therefore is al-

lowed to dry and hang. Here the heat is not so great, and the ants are less likely to find the weevil stage within, but the sun-loving Hymenoptera choose this situation for their attack, in preference to fallen squares. Certain varieties of cotton mature very early, and hence drive the weevils out sooner. Some varieties have less extensive foliage than others and hence permit greater mortality from the sun's rays. Under some conditions proliferation also destroys the immature stages by crushing. Examples of these kinds abound throughout our literature. The protection afforded insects by the plant is often a great protection against many factors, *e. g.*, the protection of cotton bolls compared with squares. The thickness of the carpels and the mass of the fiber in the bolls afford considerably more protection against cold than the squares.

3. *Cultural conditions.* Insect control is frequently effected by means of certain cultural or field practices. In the boll weevil problem it is possible to make parasite control supplement this cultural control, as has been shown in my paper, previously quoted. Our idea is to kill all of the boll weevils that can be killed, and to do this we must add every factor, which can do even a little bit. The parasites can take a given per cent which can not be touched by any given cultural method and furthermore are facilitated in part of their work by definite cultural practice.

4. *Food supply.* In a general way the amount and nature of the food supply of an insect determines its size, its fecundity, its ability to withstand climatic conditions, the rapidity of development, and its movements. The food supply is in turn controlled by climate.

5. *Duplicated mortality.* It goes without demonstration that, with so many factors of mortality possible in the case of a given insect, there will be more or less duplication. Ants carry off the evidence of mortality by both heat, fungus and parasites. Parasites attack and breed upon hosts already killed, and upon those which would have been killed by other factors. Heat kills stages which would have been otherwise killed, and in fact kills these other agencies also. Nevertheless it must be considered that, whether a parasite was needed or not in order to kill a given stage, having done so it is capable of producing offspring which may be of direct and positive value.

THE CITRUS WHITEFLY OF FLORIDA CONSISTS OF TWO SPECIES

By Dr. E. W. Berger, *Gainesville, Fla.*

That the citrus whitefly of Florida represents two distinct and well-defined species is a fact well authenticated by careful observations now extending over some months. Each species has been found by itself in several localities of the state, but both species may occur in the same locality and live on the same tree. The presence of a delicate net, consisting of hexagonal meshes, covering the eggs of whitefly in certain localities, while the eggs from other localities were perfectly smooth and glossy, is the character which first directed the writer's attention to the subject. Careful comparisons of the larvæ of the first stage revealed the fact that the larva hatched from the reticulated egg develops a waxy border between the marginal spines about as broad as the length of the shorter spines; whereas the larva hatched from the smooth egg develops no such border. Differences in the number of marginal spines of the first stage larvæ of the two species have also been noted, together with differences in the size of these larvæ. Well-marked differences between the larvæ of the fourth stage and also between the pupæ have been recognized. One or two characters for distinguishing the adults also appear to be established.

The species with the smooth eggs is no doubt the one described in 1893 by Riley and Howard in "*Insect Life*" as *Aleyrodes citri*. The species with the reticulated egg appears to be undescribed. It is neither *Aleyrodes aurantii* Maskell, *A. marlatti* Quaintance, nor *A. spinifera* Quaintance, living on citrus in the Northwestern Himalayas, Japan, and Java, respectively; nor is it *A. howardii* Quaintance, from Cuba; nor any other Aleyrodes living on citrus, so far as the writer has been able to determine. It is therefore probably a new species, unless it is some hitherto little known species described as occurring on other plants than citrus.

That the undescribed species in question also exists in Louisiana is evident from Professor H. A. Morgan's figure of the reticulated egg;[1] but Professor Morgan was evidently not aware of the existence of two types of eggs, representing two species seriously affecting citrus. He gives the name "*Aleyrodes citrifolii* (Riley, MS.)" to the species observed by him in Louisiana. The manuscript here referred to is evidently the one later published in "*Insect Life*," the name of the insect having in the meantime been changed to *Aleyrodes citri*.

[1]Special Bulletin of the Louisiana State Experiment Station, 1893.

The writer plans to prepare a careful description of this new species for publication in some entomological paper. The foregoing statements are essentially abstracts from a paper presented by the writer before the Florida State Horticultural Society at Gainesville, on May 14, 1908.

A FLEA-BEETLE ATTACKING HOPS IN BRITISH COLUMBIA

By H. J. Quayle, *Whittier, Cal.*

A Flea-beetle (*Psylliodes punctulata* Melsh), which occurs widely over the northern part of the United States, but hitherto has not been, apparently, a very important pest of cultivated crops, has been seriously injuring hops in British Columbia during the past year or two. The loss this year in the Chilliwack and Agassiz Valleys is estimated at about 80% of the crop.

During a brief visit to the territory in July it was the writer's chief mission to find the younger stages of the insect, and the eggs, larvæ and pupæ were consequently taken at a depth of from three to six inches from the surface of the ground. The larvæ feed, apparently, on the roots of the hop as well as other plants growing in the yard. But they are not restricted to the growth in hop yards, as may be inferred from finding the beetles widely separated from any hop vines. The adult beetle was found to feed upon the nettle, potato, mangel beet, turnip, dock, lamb's quarter, pigweed and red and white clover, as well as upon the foliage of the hop. There are two points that militate against an effective remedy. First, the continual emergence of the beetle, making a contact spray or mechanical means of capture, such as jarring, of but temporary value; and second, the rapid growth of the hop vines, making frequent repetitions of a poison spray necessary.

Mr. Thomas Cunningham, the provincial fruit inspector, and Mr. Charles Hayes, of the Oregon Station, are at work upon this insect, and we may expect in the near future, a more complete knowledge of its life history and the remedies available for its control.

THE EGGS OF EMPOASCA MALI LE B.

By R. L. Webster, *Ames, Iowa*

Last year, while connected with the Minnesota Experiment Station, and doing some work with the apple leaf-hopper, *Empoasca mali* LeB., I succeeded in finding a number of new facts regarding the life history of that species. During the present year, 1908, I have had some opportunity to study the same insect at the Iowa station, and am able to offer some additional data concerning the egg stage of this leaf-hopper. The results of last year's work were given in a paper by Prof. F. L. Washburn at the Chicago meeting of the Association of Economic Entomologists, and were published in the April, 1908, number of the Journal of Economic Entomology.

It is clear that the winter eggs, and those of the rest of the year, are deposited in different parts of the tree. On young apple nursery stock the eggs for the winter are deposited in the bark on the lower portion of the trees, below the first branches, and form tiny pockets or blisters on the bark. These egg blisters I found at Albert Lea, Minnesota, May 20, 1907, on three-year-old apple stock at the Wedge nursery. A young nymph was caught in the act of emerging from one of these egg blisters, so there is no doubt of their identity. This year I have found similar egg blisters on apple stock shipped to Ames from Shenandoah, Iowa.

In Minnesota last year Mr. George G. Ainslee found similar egg pockets on an apple tree which at that time were supposed to be those of *Empoasca mali*. These were much larger than the ones found by myself at Albert Lea, and I now think that they were the eggs of some Membracid which had oviposited in the bark of the apple tree. The egg pocket found and described by Mr. Ainslee measured about 1 mm. by 2 mm., much too large for a nymph, which is only .8 mm. long in the first stage. Those egg pockets found by myself, which I know certainly to be those of *Empoasca mali*, measured .4 mm. by .75 mm., approximately.

Mr. Ainslee found last year in September egg slits in the petioles of apple leaves which he thought to be those of *Empoasca mali*. This observation I have been able to corroborate during the past summer. On July 17th, in the insectary, I noticed several young Empoasca of the first nymphal stage dead on the petiole of an apple leaf, which had been immersed in water for several days. On looking closely over the petiole I found tiny slits in the epidermis near each one of the dead hoppers. These were .6 mm. in length and were a long oval in

outline. The long axis of the slit was parallel to that of the petiole. Evidently the young hoppers had emerged from the egg, but were drowned in the water as soon as they had gotten out. Later, on July 26, under similar conditions, I found a dead nymph of the first stage which was only half way out from the egg slit in the petiole, thus making certain that the true egg slits had been found. These egg slits were found in the green twigs, petioles and lower portion of the mid rib of apple leaves.

Dr. Forbes mentions what he supposed to be the summer eggs of the apple leaf-hopper in slight swellings in the petioles of the leaves.[1] It is probable that the egg slits found by Mr. Ainslie and myself are the same as those referred to by Dr. Forbes.

ANNUAL MEETING OF THE ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

The Twenty First Annual Meeting of the Association of Economic Entomologists will be held in Baltimore, Maryland, December 28 and 29, 1908. A further announcement giving detailed information concerning the place of meeting and hotel accommodations, railroad rates, etc., will be forwarded to all members about the first of November.

As it is desired to publish the program of the meeting in the next issue of the JOURNAL, and as a copy is also desired for publication in the official program of the American Association for the Advancement of Science, it will be necessary for members desiring to present papers to forward the titles so that they can be in the hands of the Secretary November 15.

In accordance with a resolution passed at the last meeting application blanks for membership have been printed and will be furnished on request.

Baltimore furnishes excellent facilities for holding a convention, and it is hoped that all members will make a special effort to be present at this the Twenty First Annual Meeting of the Association.

S. A. FORBES, President,
Urbana, Ill.
A. F. BURGESS, Secretary,
Washington, D. C.

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[1]Twenty-first Rep. State Ent. Illinois, 1900, p. 78.

ANNUAL MEETING OF THE ENTOMOLOGICAL SOCIETY OF ONTARIO

The Forty Fifth Annual Meeting of this society will be held at the Agricultural College, Guelph, on the 5th and 6th of November under the presidency of Dr. James Fletcher of Ottawa. The first session will be held on Thursday afternoon and the meeting will continue during that evening and the whole of the following day. On Thursday evening a popular address will be given by Dr. Felt, State Entomologist of New York, and short addresses will also be given by President Creelman of the College and Mr. C. C. James, Deputy Minister of Agriculture for Ontario. At the morning and afternoon meetings papers will be read by various members of the society on a variety of topics, both economic and scientific. Visitors from a distance will be very heartily welcomed, and any papers they wish to bring forward will be gladly received. Those who intend to be present are requested to inform Professor Bethune, Ontario Agricultural College, Guelph, Canada, some time during the week previous to the meeting, and to let him know the titles of any papers they wish to present.

C. J. S. Bethune.

Scientific Notes

Shade tree work in Brooklyn. The work of this city in the care of its shade trees was extended last year to include a systematic warfare against the tussock moth (our worst enemy) and other insects. In the winter, spring and during the last few weeks, egg masses of the tussock moth have been collected from trees over a large area and burned. The owners of adjoining property have been asked to clean their fences and house walls, through the medium of a postal card and also by verbal notification. The results have been most encouraging There appears to be a sad lack of knowledge among people as to the simplest methods of caring for their trees and fighting insect pests. Our work has thus served as a very efficient object lesson, if one is to judge from the numerous letters requesting attention from other sections of the city and the hundreds of queries regarding methods and formulæ.

On the hatching of the first brood of caterpillars early in June, all the trees within the cleaned area were banded with cotton batting in order to prevent reinfestation by caterpillars hatching from egg masses on neighboring fences.

A series of chemical and field tests with some of the most important brands of arsenate of lead purchased in the market revealed some very important facts regarding the worthlessness of some that were thought genuine and the good quality of others This information will prove very helpful another

year. Our spraying apparatus will also be increased by several more gas spraying machines and many barrel pumps, which will enable us to treat all the trees within the infested area within a very short time, thus destroying the larvæ when still young and most susceptible to poison.

The past season has been a bad one for most insects and many species have been abundant this year that were not injurious last season. The elm leaf beetle has been controlled by spraying with arsenical poisons for the destruction of adults and larvæ, supplemented by destroying the pupæ with kerosene emulsion in August. The bag worm was very abundant in certain centers early in the season, and serious injury was averted by collecting the bags before the eggs hatched.

Several rainy days during the winter were utilized by lectures to the men employed in this work. Not only were the fundamental principles of arboriculture presented but also the work against insect pests, their characteristics, etc., were duly discussed. These talks were copiously illustrated with specimens and colored slides. The gypsy and brown-tail moths were discussed so that should either of these species ever invade Brooklyn, the more intelligent of our men might be able to identify them and call attention thereto. The beneficial effects of these meetings have been proven by the numerous "new" insects brought in for identification, and by the better grade of work done by the men. At present there is a force of 163 men attending to the street trees of Brooklyn alone.

J. J. Levison, Arboriculturist,
Brooklyn, N. Y.

Muscina stabulans (Fallen). During the month of July, 1907, my wife in preparing beets for the table discovered that the stems were infested with maggots and called my attention to the matter. The larvæ were placed in a breeding jar, together with the stems, which were not decayed at this time, though they speedily became so. The larvæ began pupating on July 14, the first fly appearing on the evening of July 22. Dr. L. O. Howard, to whom the adults were submitted for identification, pronounced the insect to be the above named species. They were all undersized individuals and some half dozen or so were reared from the stems. During the past summer I found some very young dipterous larvæ upon a leaf of the common rhubarb or pie plant, which had begun to decay. There issued therefrom no less than 35 full-sized specimens of *Muscina stabulans*. The larvæ were found on the 25th of May and the flies began to issue on June 10. This species seems to be most common in houses about Harrisburg during the months of May and June, almost completely disappearing by July 1.

W. R. Walton.

"The mosquito lit on the sleeping man,
And looked for a place to drill,
'The world owes me a living,' he said,
And at once sent in his bill."
—*Cornell Alumni News.*

Collections from human excreta. The following species of Calypteræ were collected by the writer from human excreta during the months of July and August, 1907, and may properly be added to the list of such flies given by Dr. Howard in his paper concerning the Fauna of Human Excrement. The determinations are by Mr. Coquillett through the kindness of Dr. Howard:

Lucilia sericata, very numerous, collected in large numbers.
Lucilia sylvarum, found but sparingly.
Phormia regina, rather abundant.
Anthomyia radicum, swarming in great numbers.

My endeavors to rear any of these species from excrement have met with failure so far. In the rearings made during the past summer large numbers of a hymenopterous parasite were reared from the pupæ under observation. Mr. H. L. Viereck has identified the same as *Aphacreta muscae* (Ashm). It issued in one instance from an unidentified species of Sarcophaga.

W. R. Walton.

Snow-white linden moth, *Ennomos subsignarius* Hubn. This pest was responsible for serious injuries to beech in the Catskills last year. Extensive defoliation occurred in both the Catskills and the Adirondacks this year. The moths have been exceptionally abundant over wide areas, having been numerous at New York, Kingston, Hudson and Utica, and also have attracted attention in Albany and Troy. The insect does not appear to have been especially destructive in the last two named localities. It may be recalled that this species was well known as a shade tree pest about 1870, and has been remarkable chiefly in later years because of its scarcity. This unusual outbreak is certainly worthy of more than passing notice. The English sparrow, as is well known, feeds readily upon the moths and undoubtedly is an important factor in preventing extensive injuries to shade trees.

E. P. Felt.

Aphid on Gladioli Bulbs. A unique injury by a plant louse, referable to the genus *Aphis*, was brought to attention last spring. The aphids breed in large numbers on the base of the bulbs around the origin of the roots, beginning in early spring as soon as the temperature of the storage warehouse warms up and continuing to reproduce till toward the end of July. The insect is so abundant on certain varieties as to almost fill with exuviæ many of the interstices in small boxes containing a dozen or so bulbs. Exuviæ and dead plant lice can be swept up in large numbers in a badly infested warehouse. Bulbs affected by this insect are sickly, weakened and may fail to flower.

E. P. Felt.

JOURNAL OF ECONOMIC ENTOMOLOGY

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OCTOBER, 1908

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Reprints of contributions may be obtained at cost. Minor line figures will be reproduced without charge, but the engraving of larger illustrations must be borne by contributors or the electrotypes supplied. The receipt of all papers will be acknowledged.—Eds.

The accurate characterization and delineation of destructive insects is one of great importance to the economic entomologist. We believe that the policy of the JOURNAL should be rather broadly construed in this matter, and it is therefore a pleasure to present in this number a well illustrated, descriptive paper by Prof. Gillette—the first part of an important contribution to our knowledge of certain destructive plant lice. This article is quite distinct from the usual and highly serviceable economic account; nevertheless papers of this character are most useful to the practical entomologist who is frequently called upon to discriminate between closely allied, injurious forms. General systematic papers are very serviceable, but comparative descriptions of all stages such as given in the above-mentioned article will do much to make our identifications more accurate. We hope that others will give attention to this more technical side of economic entomology.

The next session of the Association of Economic Entomologists is not remote, and the editor takes this opportunity of calling attention to the desirability of having papers written out prior to presentation. The JOURNAL was started primarily for the purpose of affording a more prompt means of publication for the proceedings, and this end can be attained only by the coöperation of all. The period between the meeting and the issue of the first number in 1909 is limited, and unless the major portion of the papers are in the hands of the secretary at the close of the meeting, the prompt issue of the proceedings will be a matter of considerable difficulty. We trust that all those contemplating the preparation of papers will bear this in mind.

Reviews

Report of the Government Entomologist for the year 1907, 1908, by C. P. Lounsbury, p. 45–57.

This summarized report shows that a large amount of work has been performed during the past twelve months. Nursery inspection occupied considerable time and is briefly considered, together with a discussion of measures for excluding undesirable stock. A number of destructive insects are briefly noticed and a most interesting method of destroying locust swarms by spraying with an arsenical poison is discussed in some detail. Considerable space is devoted to a Plasmopara or downy mildew affecting grape. Brief observations are given on the value of the codling moth parasite, *Calliephialtes messor*, introduced several years ago into California. Attempts have been made to secure the introduction into South Africa of a red scale parasite from California.

South Africa offers immense opportunities to the economic entomologist, since he has to do with a fauna almost unknown to the practical scientist. Those acquainted with the brilliant work of Prof. Lounsbury in the study of African ticks and other injurious insects, and possessing some knowledge of the possibilities, will agree with the reviewer that it is a mistake and distictly unwise to insist that the entomologist's reports be cut down to mere summarized statements, as has been true in the case under consideration during the past three years. Records of extended investigations can not be stored to advantage in manuscript form. There is always grave danger that important observations may thus be buried beyond recovery. The results of studies should be published, in order that they may become available to others working along the same lines. They in turn would be of service to the original investigator, since the truth is seldom fully established by one series of experiments, but rather by a number of students, each testing the results of the others. Those cognizant of the immense number of injurious insects and the variations in their habits and methods of work will agree in emphasizing most strongly the value of illustrations as a necessary supplement to the text. Frequently the figure of a destructive form leads a man to consult accounts which would otherwise be ignored. An entomological office unable to issue well illustrated, detailed accounts of its work has its usefulness circumscribed in a most deplorable manner.

E. P. F.

Preliminary Report upon Experiments with Powdered Arsenate of Lead as a Boll Weevil Poison, by Wilmon Newell and T. C. Barber. Circular No. 23, State Crop Pest Commission of Louisiana, 1908, 40 pp.

This circular gives a brief summary of the results secured by using Paris Green for controlling the boll weevil in Texas and Louisiana since this insect has become a serious pest. A statement of the results of field and cage experiments in Louisiana is given. The work led to the experimental use of powdered arsenate of lead in the spring of 1908. The results of a series of cage experiments where this substance was used are reported, but the data

on the field experiments will be published later. In the cage experiments 70 per cent of the weevils present were destroyed by applying powdered arsenate of lead just before the squares were formed, at the rate of 1½ pounds per acre. The use of this substance also proved cheaper and more effective than Paris Green in controlling the cotton caterpillar, *Alabama argillacea*. The circular sets forth that the application of poison can be considered as only one of the methods of controlling the boll weevil. The results secured should be of great value to the cotton planters of Louisiana and the South.

A. F. B.

The Mound-Building Prairie Ant, by T. J. HEADLEE and GEORGE A. DEAN. Kansas Agricultural Experiment Station Bul. 154, 1908, p. 165–80.

This bulletin makes substantial additions to our knowledge of the life history and habits of this ant, *Pogonomyrmex occidentalis* Cress., a species which has proved of some economic importance because of its injuries to grain fields and also on account of the annoyance inflicted upon man and domestic animals. Experiments have resulted in perfecting a modification of the usual treatment with carbon bisulfid, in that an inverted tub is used to confine the volatile insecticide. There are a number of excellent illustrations, but unfortunately they and the general appearance of an otherwise most excellent bulletin are somewhat marred by the illustrations being on a poor grade of paper.

E. P. F.

State Crop Pest Commission of Louisiana, Second Biennial Report of the Secretary for the years 1906–1907, by WILMON NEWELL, 1908, p. 1–31.

This summarized account of two years' work shows that much has been accomplished. The major portion of the time has been given to the study of the more important pests, such as the cattle tick, boll weevil, white fly and Argentine ant. Nursery inspection is another very important line of work. The report shows that the entomologist has at his disposal the services of five assistant entomologists, in addition to a clerical staff. These men, in coöperation with the United States Department of Agriculture, have done much toward bettering entomological conditions in the southern states. The report, together with the fourteen circulars bound therewith, as an appendix, are well printed, excellently illustrated and most commendable on account of the clear, succinct style.

E. P. F.

A Record of Results from Rearings and Dissections of Tachinidae, by CHARLES H. T. TOWNSEND, U. S. Dept. Agric., Bur. Ent. Tech. S. 12, Prt. 6, 1908, p. 95–118.

This bulletin is an extremely important addition to our knowledge of the Tachinidæ, a compact group which many entomologists have tacitly assumed to possess much similarity in habit. Mr. Townsend's investigations show such to be very far from the case. A most striking result is his confirmation

of Sasaski's discovery of the leaf-oviposition habit, it occurring not only in exotic forms, but also in a number of native species. Aside from the well known, and commonly supposed characteristic, host-oviposition habit of many species, Mr. Townsend describes supracutaneous host-larviposition, subcutaneous host-larviposition with an accompanying acute ovipositor, and, most interesting of all, leaf-larviposition. This bulletin likewise records remarkable variations in the habits of the larvæ in different stages. The variations in the number of generations annually and differences in habit are not only interesting to the scientist, but, as shown by Mr. Townsend's observations, are of great importance to the biologist engaged in establishing or propagating these forms. The experiments in providing species producing more than one generation with alternate hosts is another exceedingly practical matter. A most intimate knowledge of parasites is a necessity if the imported material is to be used to the best advantage. The entire bulletin is a credit to all concerned in the investigations as well as to the bureau having charge of the work. It is, we trust, but the precursor of a more extended discussion of this group, and probably the forerunner of equally valuable contributions to our knowledge of other groups of parasites and other natural enemies. It illustrates in an emphatic manner the necessity of exhaustive studies of the biology and various stages of economic insects, and suggests most strongly that an extremely rich field awaits the student of biology in various supposedly well known groups.

E. P. F.

Third Annual Report of the State Entomologist, 1907, by E. F. Hitchings, Maine State Department of Agriculture, 1908, p. 1–105, plates 20.

This report, as indicated upon its title page, deals largely with the gypsy and brown-tail moths, besides discussing a number of attractive or destructive species. A detailed account of the work is given, the methods being similar to those in vogue in Massachusetts. A number of excellent plates illustrate this feature of the report. The entomologist reports upon the nursery inspection work, gives interesting notes upon birds, and some details relating to the exhibition of insect collections at state fairs. An unusual feature for an entomological report is an essay on apple orcharding, in which considerable attention is given to various fertilizers, manures, methods of trimming, grafting, thinning, etc., in addition to a discussion of some of the principal injurious insects and fungous diseases.

E. P. F.

The More Important Insects Affecting Ohio Shade Trees, by J. S. Houser, Ohio Agricultural Experiment Station Bull. 194, 1908, p. 169–243, 21 plates.

This bulletin comprises most excellent summarized discussions of most of the more injurious species affecting shade trees in Ohio. The introductory matter discusses the necessity of and difficulties in controlling insect pests in cities and emphasizes the advisability of municipal work. It also discusses the relative immunity of trees from insect injuries and advises mixed planting. A new shade tree pest noticed is the Catalpa bud gnat, *Cecidomyia*

catalpae Comst. The bulletin closes with a discussion of spray apparatus and of the standard contact and internal isecticides. The plates are composed mostly of original, well selected figures. The process illustrations would have been materially improved had they been printed upon a better grade of paper. The bulletin as a whole is most commendable and should prove of great service to all interested in shade tree protection.

E. P. F.

How Insects Affect Health in Rural Districts, by L. O. HOWARD, U. S. Department of Agriculture, Farmers' Bulletin 155, 1908, p. 1–19. 16 figures.

This authoritative, summary discussion deals particularly with mosquitoes as carriers of malaria and yellow fever, and with the house fly as a disseminator of typhoid fever. The comparative discussion of the sanitary conditions prevailing in city and country is a particularly valuable feature.

Current Notes

Conducted by the Associate Editor

During the past summer several members of this association have been honored in foreign countries. Among these the following should be mentioned: Prof. Wm. B. Alwood, Charlottesville, Va., has been awarded a silver medal and diploma of the Société National d'Agriculture de France, and the president of the French Republic has conferred upon him the cross of Officer du Mèrite Agricole.

Dr. L. O. Howard, chief of the Bureau of Entomology, has been made an honorary member by the Société National d'Acclimatation de France.

An entomologist highly honored. It is very gratifying to note that Dr. W. J. Holland, member of the Association of Economic Entomologists and former chancellor of the Western University of Pennsylvania, now director of the Carnegie Museum, has been recently honored by both Emperor William of Germany and President Fallieres of the French Republic, who conferred upon him the orders of the Knight of the Crown and Officer of the Legion of Honor. Doctor Holland is the first man in the United States to be thus doubly honored. These decorations will be worn by Doctor Holland only on very special occasions, since we do not, like Europeans, make a practice of wearing such insignia on public occasions. Brother entomologists will unite with us in congratulating Doctor Holland upon the high honors which have befallen him.

Mr. G. D. Smith, a graduate of the Louisiana State University, class of 1908, has been appointed assistant entomologist to the Louisiana State Crop Pest Commission.

Mr. R. C. Treherne of the Ontario Agricultural College, who has been employed by the Louisiana Crop Pest Commission as temporary assistant, has returned to Guelph, Canada, to complete his course of study.

Mr. W. F. Fiske, who was in charge of the Gypsy Moth Parasite Laboratory at Melrose Highlands, Mass., sailed for Europe August 25. He will travel in England and France, visiting the museums and securing information which will be of especial value in the work of importing parasites of gypsy and brown-tail moths.

Mr. Charles W. Flynn, who is taking a medical course at the University of Pennsylvania, has been employed during the summer by the Bureau of Entomology as temporary assistant in the cotton boll weevil investigations.

Mr. W. Harper Deane has been appointed special field agent of the Bureau of Entomology, and will be connected with the investigation of cereal and forage crop insects.

Dr. Jas. A. Nelson, formerly honorary fellow in entomology and invertebrate zoölogy at Cornell University, has accepted an appointment with the Bureau of Entomology, Washington, D. C., and will investigate certain problems in the embryology of the honey bee.

Dr. E. F. Phillips and Dr. G. F. White of the Bureau of Entomology spent the summer in southern California, carrying on experiments in treating American foul brood.

Mr. Burton M. Gates and Mr. A. H. McCray, who have been employed in the agricultural investigations of the Bureau of Entomology, were granted a furlough October 1. The former will attend Clark University and the latter will finish his course at the Ohio State University.

Mr. Robert Newstead, lecturer in economic entomology and parasitology in the Liverpool School of Tropical Medicine, will visit Jamaica in November to investigate the ticks and other insects which transmit animal diseases.

At a recent meeting of the Association of Economic Biologists held at Edinburg, Mr. A. E. Shipley, president of the association, delivered an address on "Rats and Their Parasites."

Mr. W. R. Thompson, who has been employed during the summer at the Gypsy Moth Parasite Laboratory, Melrose Highlands, Mass., has returned to Guelph, Ontario, to finish his course at the Ontario Agricultural College, where he is specializing in economic entomology.

Mr. Douglas H. Clemons, who has for the past two years been employed at the same laboratory, has been appointed assistant in the Division of Insects at the U. S. National Museum, Washington, D. C. He will work principally on the coleoptera.

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A EUROPEAN ANT (MYRMICA LEVINODIS) INTRODUCED INTO MASSACHUSETTS

It is surprising that very few ants have been introduced into North America from Europe, notwithstanding the great facilities for transportation between the two countries, the similarity of their climatic and physiographic conditions and the close affinities of their ant-faunas. One species only, *Tetramorium cespitum*, has been recorded as of European provenience, and this, though of many years' residence among us, is still confined to the Atlantic States (Connecticut to Maryland). I have recently come upon a second ant which must have been introduced into Massachusetts. Early in September I found a large colony of *Myrmica levinodis* Nylander in the grass at the edge of the Arnold Arboretum, a few steps from the Bussey Institution, at Forest Hills, Mass. The workers were attending plant-lice (*Aphis* sp. near *rumicis*) on a few stalks of *Chenopodium album* very near their nest. Some days later a second colony was discovered at the edge of Franklin Park, about a mile from the Arboretum. Early in October a third colony was seen on a lawn near the postoffice in Jamaica Plain. Though by no means common, it is certain that this ant has begun to spread over the country about Forest Hills.

M. levinodis was formerly regarded as one of a number of subspecies of a single circumpolar species, *Myrmica rubra* L. Emery[1] has recently raised the subspecies *scabrinodis, sulcinodis*, etc., to specific rank, but has retained *levinodis* and *ruginodis* as subspecies of *rubra*. It is clear, as he remarks, that Linné must have described one or both of these forms as *rubra*, since he introduced into his diagnosis the

[1]Beiträge zur Monographie der Formiciden des paläarktischen Faunengebiets. Deutsch. Ent. Zeitschr., 1908, pp. 165–182.

words "*pessime nostratum pungit,*" and it is now known that none of the other European or North American forms of *Myrmica* (except *rubida* and *mutica,* which form a group by themselves) has well-developed stinging powers. As there are no means of telling to which of the two forms Linné referred, and as they are connected by numerous intermediate varieties, known to European myrmecologists as *levinodis-ruginodis,* we had best adopt Emery's interpretation.

A few years ago I described[1] a form of *levinodis* from Woods Hole, Mass., as var. *bruesi.* On comparing workers of this and of the *levinodis* from Boston with workers from a number of colonies from various parts of Europe (Scotland, England, Norway, Sweden, Germany, Austria, Switzerland and Russia), I find that the Boston specimens are indistinguishable from the typical Old World form. They are yellowish, with brownish head, feebly sculptured head and thorax, and with smooth and shining epinotal declivity and postpetiole. These characters will serve to distinguish *levinodis* from any of our American Myrmicas. The workers of the var. *bruesi* have the head and thorax somewhat more coarsely rugose, and the postpetiole, though smooth, is subopaque, so that this variety is more like some of the European intermediates between *levinodis* and *ruginodis.* The males of *bruesi,* however, have prominent, suberect hairs on the legs, like the males of the true *levinodis.*

I believe there can be no doubt that both the Boston and Woods Hole specimens are the offspring of females that were accidentally imported from Europe. The mothers of the Boston colonies were in all probability introduced into the Arnold Arboretum with European trees or shrubs, and as the few colonies observed by Mr. C. T. Brues and myself at Woods Hole occupied a very circumscribed locality adjoining Mr. Fay's rose-garden, they probably had a similar history.

[2]Forel has described two subspecies of *rubra* from North America as *neolevinodis* and *champlaini,* and if these be regarded as indigenous to the country, it is clear that the Massachusetts colonies of *levinodis* and *bruesi* might be similarly interpreted. The Swiss myrmecologist states that *M. neolevinodis* was introduced into Hamburg "from New York with iris roots." The worker is described as having thicker and shorter antennæ than the typical *levinodis,* with more decidedly bent scapes, a shorter petiole, with nearly straight anterior declivity and somewhat coarser cephalic and thoracic sculpture. As I have never been able to find any form of *levinodis* in New York state, and as the

[1]New Ants from New England. Psyche, XIII, 1906, pp. 38-41; pl. IV.

[2]Formiciden des naturhistorischen Museums zu Hamburg. Mittheil. aus d. naturhist. Mus. Hamb. XVIII, 1901, pp. 45-82.

iris roots in which Forel's form were found may have reached Hamburg from Japan or Siberia by way of New York, I am not convinced that *neolevinodis* is an American insect. *M. champlaini* was taken by Forel himself in a meadow near Quebec. The worker of this subspecies is described as being very similar to that of *neolevinodis*, but as having teeth instead of spines on the epinotum. The sculpture of the head and thorax is coarser than in the European *ruginodis*, the petiole and postpetiole are smooth except for a few lateral furrows, and the antennæ are as short as those of *neolevinodis* or even shorter. As Quebec has long been in direct and intimate communication with Europe, it is not at all improbable that *M. champlaini* is merely a rather pronounced imported variety of *levinodis*. Finally, I may state that although I have brought together a very large collection of Myrmicas from all parts of temperate North America, I have never been able to find any forms allied to *levinodis* except the two mentioned above. I am therefore of the opinion that the true *M. rubra*, as recently defined by Emery, is not indigenous to North America.

The preceding remarks have merely a theoretical bearing, but the introduction of *M. levinodis* into the United States may have some economic importance, for this ant is the most disagreeable of the palearctic Myrmicas. It forms much more populous colonies than *scabrinodis, sulcinodis, brevinodis* and their numerous varieties, and its workers are aggressive and sting severely.

It is very fond of attending aphids and, unlike our timid native Myrmicas which live in the retirement of woods, bogs, heaths and waste places generally, it prefers to nest in cultivated soil. Hence it may become a nuisance in lawns and dooryards, like the fire-ant (*Solenopsis geminata*) of the Southern States. It is, of course, impossible to ascertain how long the typical *levinodis* and its variety *bruesi* have been living in Massachusetts, or whether their spread will be checked by any of our native ants. The aggressive character of the imported forms would seem to indicate that they will meet with little or no opposition from the allied indigenous species, and as *levinodis* flourishes in Norway and the Alps, it will hardly find our severe winters a serious obstacle to the growth and multiplication of its colonies. It may be advisable, therefore, to keep this belligerent immigrant under observation.

W. M. Wheeler.

Bussey Institution,
Forest Hills, Boston, Mass.,
October 1, 1908.

WASP STORING KATYKIDS IN A WELL

By E. S. TUCKER, *Bureau of Entomology, U. S. Dept. of Agric.*

Two years ago in August a correspondent at Osage City, Kansas, sent me some specimens of a narrow-winged katydid, which were identified as *Scudderia curvicauda* De G., and in his letter he stated that they had been drawn up in a bucket of water from a well 30 to 35 feet deep, where the insects were floating. A few days before these bodies were taken he had observed a large black wasp in the act of carrying one of the same kind of katydids into the well and saw the wasp drag its prey into a cranny of the rocks, about a yard below the surface of the ground. No definite description of the wasp was given further than that it was over an inch long and "slender-waisted." One or two torpid katydids were seen lying on the very edge of rocks in the wall near the spot where the above example had been stored away, from which position any of the bodies might easily slip and fall off into the water below. The number of bodies floating in the well had been increasing during the week until twenty or thirty were visible. In the meantime some of them, probably a dozen specimens, had been drawn up in buckets of water and thrown away. One of these specimens evinced faint indications of life by movements of its mouthparts.

The question was asked if these bodies showed signs of having been stung and if eggs had been laid upon them by the wasp. To prove that the bodies were stung, the act of stinging must be witnessed, and since the specimens had become partly macerated, no evidence of eggs could be detected, though there remained no doubt, judging from the habits of rapacious wasps, but that the katydids had been stung when captured, and the wasp's intent upon storing them would naturally be for the purpose of depositing an egg in a safe place with each body.

Having concluded that the wasp had appropriated the well as her rightful property, the correspondent wanted to know if she intended to stock the crannies of the wall with paralyzed katydids so that her progeny when hatched from the eggs laid with these stored bodies could be reared upon them. In such a case, he asked if a host of wasps would likely hatch out soon as perfect insects. A brief explanation of the life history of robber-wasps was given in reply. However, as the matter stood, the bodies of katydids which fell into the water became decomposed and rendered the water objectionable for use on account of danger of pollution. According to the owner's statement, this trouble had never happened before to his knowledge, at least within fifteen years. He had already considered the advisabil-

ity of cleaning out the bodies of the insects in order to keep the water pure. The wasp, of course, should be caught and killed to prevent further introduction of bodies into the well.

My desire to obtain the specimen if possible and know definitely what kind of wasp was doing the work led to further correspondence, which brought the information that unsuccessful attempts had been made to capture a specimen because the insect was exceedingly wary, although two wasps then frequented the well. They were mentioned as being the largest black kind of solitary digger-wasp common to the country. They flew very swiftly and were seen to alight only when they entered the well. Shortly after the receipt of this communication the correspondent visited me and pointed out in a collection of insects the wasp known as *Proterosphex pennsylvanica* L., which he positively declared was the kind that came to the well.

NOTES ON ASPIDIOTUS DESTRUCTOR (SIG.) AND ITS CHALCID PARASITE IN TAHITI

By R. W. Doane, *Stanford University*

For many years the Transparent Cocoanut Scale, *A. destructor* Sig., has been an important enemy of the cocoanut and other palms in many parts of the tropics. During the last few years it has been doing particular damage to the cocoanut trees in the Society Islands. On some of these islands many of the trees have been killed and others so badly affected that they bear no nuts. On some of the coral islands the conditions are still so bad that practically no crop is gathered. On Tahiti and some of the more important of the other islands, plantations that a few years ago were yielding no nuts are now in full bearing again and the trees are looking fine and thrifty. In the interests of one of the planters I visited these islands last summer to study the conditions that controlled the appearance and disappearance of this pest. None of the planters has any idea of when the insect was introduced there, but few of them, in fact, realize that it is an insect that is causing the so-called "blight" on their trees. But as it is now common on practically all of the South Sea islands it probably found its way into the Society Islands very early, as Tahiti is a central point, from which ships come and go to all south Pacific ports. A few years ago it must have begun increasing very rapidly. I was told that in Tahiti the "blight" was so bad and spread so rapidly from one part to another that it seemed that all the trees would be destroyed. At one time so many of the plantations were affected, par-

ticularly on the leeward side of the island, that it was even difficult to get cocoanuts to drink, and of course no copra was exported.

The insect attacks all parts of the tree, except the roots and old trunk, in all stages of its growth. The first few leaves of the young plant are often completely covered on the underside with the scales, causing them to turn a characteristic yellow color and usually killing the young plant unless relief comes. On the older trees all parts of the leaves may be infested, the flower-spike is usually well covered and the husk of the nut is often so completely covered that it would seem impossible for another insect to find lodgement.

On some parts of the island I found many of the trees thus covered, some of the younger ones dying, the older ones having no nuts, but on most of the plantations the scale seems to be disappearing at a very rapid rate. Trees that three years ago bore no fruit are now in fine foliage and bearing their full quota of nuts. The planters say that this change was brought about by different weather conditions, but my studies there show that the primary cause of this sudden change was the introduction and development of the chalcid parasite *Aspidiotiphagus citrinus* Craw (identification kindly confirmed by Doctor Howard). Whether the parasite was introduced with the scale and did not find conditions favorable for its development until the scales were very abundant or whether it was introduced later, we could not tell, but it is there in immense numbers now. On some trees 50 to 75 per cent of the scales were parasitized and on many others practically all the scales were dead, but I could not find indications of the parasites' work on all of them. As the parasite may sometimes escape between the upper and lower scales instead of making the characteristic round hole in the upper scale, it is not always easy to tell by simply examining the scale whether the insect has been killed by the parasite or not. Many of the dead insects under scales that show no signs of the parasite having issued will exhibit unmistakable signs of its work when they are examined with the microscope. On a badly infested leaf I have seen as many as ten adult parasites within a radius of 3 or 4 inches walking about over the scales, stopping now and then on one, presumably to deposit an egg.

I have seen specimens of this scale more or less badly parasitized from Tahiti, Morea, Titioroa, Raiatea, Tahaa Huaheine and Flint Island. As the parasite is already so well distributed the only recommendation made to the planters was that they introduce it into groves where it does not seem to be present or occurs as yet in small numbers. I believe that, under normal conditions, the parasite will soon have this scale so well under control that it will no longer be a menace to the trees.

WORK OF THE BUREAU OF ENTOMOLOGY AGAINST FOREST INSECTS

By A. D. Hopkins, *Washington, D. C.*

Historical

Prior to 1902 the work in the United States on insects affecting forest trees consisted of local observations by state and government entomologists in connection with general studies of insects in their relation to agriculture, but no one, up to that time, had given special attention to the investigation of the forest insects of the entire country and very little was then known of the principal insect enemies or the character and extent of their depredations.

Under the act establishing the Entomological Commission of the Department of the Interior, and under subsequent acts to March 3, 1881, two publications were issued, one of 275 pages on insects injurious to forests and shade trees, issued as Bulletin 7 of the Department of the Interior in 1881; the other, an enlarged and extended edition of the first, entitled "The Fifth Report of the Entomological Commission," containing 855 pages and issued by the Department of Agriculture in 1890 (under joint resolution, Congressional Record, July 7, 1882). These publications comprised a compilation of practically all of the available literature on the subject up to the date of submittal, in 1887, but included little of practical value on the control of the insect enemies of the forest proper.

In 1891 the investigation of forest insects was inaugurated as a special entomological feature of the work of the West Virginia Agricultural Experiment Station, and was continued until July 1, 1902. In the meantime the Division (now Bureau) of Entomology employed the entomologist of the West Virginia Station to conduct special investigations in California, Oregon, Washington and Idaho in the spring of 1899; in Maine in the spring of 1900; in New York in 1901; and in the Black Hills of South Dakota in the fall of 1901 and spring of 1902. Up to July 1, 1902, the West Virginia station had issued 49 publications of 855 pages, with 16 plates and 236 figures, and the Division of Entomology 3 publications of 99 pages with 23 plates and 10 text figures, based on the results of original investigations of forest insects.

On July 1, 1902, the office of Forest Insect Investigations was established under the general appropriation for entomological investigations, as one of the special branches of the work of the Division of Entomology. The objects, as set forth in the general project, were to

conduct original investigations in the forest and laboratory to determine (1) the principal insect enemies of forests and forest products; (2) the character and extent of the problems which, on account of the losses involved, demand special attention; and (3) the more important facts in the life and habits of the destructive insects, local forest management, lumbering operations, beneficial insects and other natural influences upon which to base conclusions and recommendations relating to practical methods of preventing losses.

Up to the present time investigations have been conducted in all of the principal forest regions of the country. The subjects which have received special attention are indicated by the titles of the following projects:

1. Insects of the Black Hills Forest.
2. Insects of the Southern Forests.

2a. Relation of Sulphur Dioxid in Smoke to Injuries by Insects to Forest Trees.

3. Insects of the Middle and Eastern Forests.
4. Insects of the Northwestern and Pacific Coast Forests.
5. Insects of the Southwestern Forests.
6. Insects of the Northern Section of the Rocky Mountain Forests.
7. Explorations and General Study of Forest Insects in the U. S.
8. Forest Reproduction Insects.
9. Relation of Environment to Injury to Forest Trees by Insects.
10. Interrelation of Insects and Forest Fires in the Destruction of Forests.
11. Insect Injuries to Forest Products.
12. Bark Weevils of the Genus Pissodes of North America.
13. Hickory Insects.
14. Ash insects.
15. The Scolytid Bark and Timber Beetles of North America.
16. The Buprestid, or Flat-Headed, Bark-and-Wood-Borers of the United States.
17. The Cerambycid, or Round-Headed, Wood-Borers of the United States.
18. Beneficial Forest Insects.
19. Black Locust Insects.
20. Trap Tree Experiments of Biltmore Estate, N. C.
21. Investigations of Damage by Wood-Boring Insects to Deadened and Felled Cyprus Timber in the Southern United States.
22. Breeding Insect-Resisting Black Locust.
23. Larch Sawfly in Northern Michigan.
24. Relation of Storm-Felled Timber in Mississippi to Depreda-

tions by Barkbeetles, and General Study of the Forest Insect Fauna of Western Texas and Southern New Mexico.

25. Investigations in the National Forests.

26. Inspections and Estimates of Insect-Killed Timber in the National Forests of Colorado.

27. Injuries by Bark- and Wood-Boring Insects to Trees Defoliated by the Gypsy Moth and Browntail Moth.

28. Diseases of the Larch Sawfly.

29. The Fauna and Flora of a Larch Swamp at Cranesville, W. Va.

30. Breeding Insect-Resistant Forest Trees.

31. Practical Application of Results of Forest Insect Investigations —Forest Insect Control as Applied to Private Interests.

32. Insect Control of the National Forests—Coöperative project, Bureau of Entomology and Forest Service.

33. Systematic and Economic Investigations of the Bark Lice of the Genus Chermes.

Work on a number of these projects has been completed, and full reports and recommendations published, as well as expert information and advice given out in correspondence. Encouraging progress is being made on the remainder, some of which it will take many years to complete.

Results

Satisfactory progress has been made towards the attainment of some of the fundamental objects of the investigations, one of which has been the laying of a substantial foundation for forest entomology in this country, on which future progress can be made along the lines of acquiring, disseminating, and applying information of immediate practical value in the protection of our forest resources. The principal results of the past six years' work which have contributed to this end may be summarized as follows:

Acquired New Information

(1) The principal insect enemies of the forest and forest products of North America, and the general character and extent of their depredations have been determined;

(2) Evidence has been accumulated which indicates quite clearly that insects are now causing a greater average annual loss of matured timber and forest products in the United States than that resulting to the same class of resources from forest fires. It has been determined that many extensive denuded areas of the Rocky Mountain region, supposed to have been caused by fire, were primarily due to

widespread depredations by insects on the living timber previous to the fire. In fact, the results of the investigations have clearly shown that in the future successful management of American forests the insect problem must rank with the fire problem, as well as with many other problems which heretofore have received far greater attention by expert foresters and the public.

(3) Many of the problems which, on account of the losses involved, demand special investigation, have been located, and much information of practical value relating to them has been acquired.

(4) The more important facts in the life history, habits, and practical methods of control relating to some of the more destructive insects have been determined.

(5) It has been demonstrated that some of the most destructive enemies of American forests can be controlled with little or no cost over that involved in ordinary forest management and business methods if the expert information now available is properly utilized.

(6) A mass of original data has been collected relating to forest insects in general, including not only those which are destructive or injurious, but those which are beneficial or neutral in their relation to the forest, and represented by a collection of more than a million specimens of insects and their work.

(7) The accumulated evidence clearly indicates that the insect damage to forest growth and manufactured commercial and utilized forest products of the United States represents losses aggregating more than $100,000,000 annually.

(8) As a direct result of the investigation of forest insects (conducted by this Bureau) during the past six years, at a cost of less than $53,000, there has been accumulated a reserve fund of information now available through publications, correspondence, and field demonstrations, which, if properly utilized for practical application, will evidently prevent a large per cent of the annual losses at a very small cost.

Practical Application

The increasing interest in the subject of preventing losses from depredations by forest insects manifested by owners of forests and farmers' wood lots, and by manufacturers and consumers of forest products throughout the country, also by the Forest Service in its efforts towards the control of extensive depredations in the National Forests, indicates that there is a quite general practical application of some of the disseminated information and that there is an increasing tendency to rely on expert advice as a guide to securing the best results.

Some of the results of the practical application of information based on entomological investigations which have been reported or observed may be mentioned as follows:

The control of the eastern spruce beetle in northeastern Maine and the saving of $100,000 to one firm; the complete control of the hickory bark beetle on Belle Isle Park, Detroit, Michigan, where the total destruction of one of the attractive and valuable features of the Island was threatened.

The complete control of an alarming outbreak of the Black Hills beetle in the vicinity of Colorado Springs and Palmer Lake, Colorado, and the adjoining National Forests, thus protecting the pine timber, which is one of the valuable and attractive features of the region, representing a cash value of several million dollars.

The complete control of the same insect, which was threatening the destruction of the pine timber on an extensive estate in the vicinity of Garland, Colorado, which would have resulted in a loss of timber and reduced value to the state of perhaps more than a million dollars.

Our recommendations for the control of powder post insects have been adopted by many of the leading manufacturers of seasoned hardwood products and by dealers and consumers of the same, and it is evident that it has resulted in the saving of many millions of dollars' worth of property.

The real value, however, of these examples of successful control is far greater than that represented by the amount of property protected, since they have served to demonstrate:

That some of the most destructive and dangerous enemies of the eastern and western forests can be controlled at slight or no expense whenever the infested timber can be utilized within a given period after it is attacked;

That manufacturing and business methods can be so adjusted that without additional expense a very large per cent, and in many cases all, of the great losses from powder post injury can be avoided;

That by the adoption of improved methods of forest management and the proper adjustment of certain details in such management to meet the requirements for prevention of insect depredations, a large per cent of the losses may be avoided without additional expense;

That, as a rule, it is useless and undesirable to attempt the extermination of an insect enemy of the forest. It is only necessary to reduce and weaken its forces so that it cannot continue an aggressive invasion but must occupy a defensive position against its own enemies and become dependent upon favorable conditions resulting from the

negligence and mismanagement of the owners of the forests and the manufacturers of forest products;

The absolute necessity of expert entomological advice as a guide to doing the proper thing at the proper time and at the least expense to secure the best results.

CYANIDE AS AN INSECTICIDE

By R. S. Woglum, *U. S. Bureau of Entomology*, and
William Wood, *Los Angeles Horticultural Commission*

Cyanide of potassium has been used for many years as one of the ingredient chemicals for obtaining hydrocyanic acid gas, the most powerful and successful of gaseous insecticides. The writers are not aware of cyanide of potassium having been previously suggested in literature as an insecticide in itself. From experimentation we have found it most efficient in the destruction of a common form of red ant.

In the rear yard of the California Citrus Substation, of the United States Bureau of Entomology, at Whittier, is a spot of hard-packed bare ground about 20 by 30 feet. This ground contained several scores of exit burrows of a common red ant. During the cooler part of the day ants were so numerous on this spot that it was impossible for a person to walk here without stepping on as many as fifty at every move. The insect became such a nuisance that steps were taken for its control. Carbon bisulphide was first tried, but the expense of the material made it prohibitive for so many burrows. Later a spray of cyanide of potassium, one half of an ounce to a gallon of water was used on part of this ground and resulted in destroying almost all ants running about on the part sprayed. This solution, although successful, acted so slowly that it was decided to double its strength. The next evening when the ground was seemingly alive with ants the entire spot was thoroughly sprayed with a solution of one ounce to the gallon of water. This not only very quickly destroyed all ants on the ground, but also such as emerged from the burrows several minutes afterward were overcome by the fumes which were given off from the damp ground. The following day less than a quarter as many ants were moving over the ground as previously. The dead ants had been collected into heaps at different places by those which remained alive.

No farther efforts to exterminate were made for two weeks, at the end of which the ants had become almost as numerous as ever. Then a pit large enough to hold a quart of solution was hollowed out at the

exit of each burrow and filled with the poison. The whole ground was gone over in this manner. An examination was made the next day and resulted in finding less than twenty-five live ants on all the ground treated. In and around some of the pits were heaps of dead ants which apparently had been carried out by such members of the colony as escaped destruction. A second treatment of these colonies usually reached what still remained alive. Where no dead ants had been brought out, probably the entire colony was destroyed. One of these burrows was opened up with the result of finding pockets filled with dead ants as much as one and one half feet below the surface. A few days after using this insecticide the pits were refilled and the ground leveled. Ten days later an examination showed about a dozen fresh burrows of apparently very weak colonies. A second yard was treated after the same manner with almost complete eradication.

Our success with this cyanide solution in almost freeing ground of ants by the use of one, or a partial second, application leads us to believe that under favorable conditions ants (at least some species) can be entirely eradicated from a piece of ground by repeated applications. The poisonous gas from this solution must penetrate deep into the ground. A strong odor of the gas was evident in a burrow opened up two days after the solution was applied. It is entirely possible that this solution will prove of some value against the ground colonies of the Argentine ant.

The success obtained against the ground form of ants suggested that the insecticide might be put to some use against various ground forms of insects as woolly-aphis, thrips, etc. To determine this point it was first necessary to learn if the solution was injurious to plant life. Two gallons were poured around the base of a large orange tree; Jerusalem cherry bushes and nursery trees of the orange and peach were treated with from one to two quarts of the solution. The orange tree was severely injured, some of the nursery stock was killed while the Jerusalem cherry bushes were injured more or less. This result would appear to demonstrate that the solution is injurious to plant life, which fact would place a limit upon its usage. The cost of the solution is from 1½ to 2 cents per gallon.

The use of potassium in powdered form for the destruction of ants was recommended in 1904 by Prof. H. A. Gossard in Bulletin 76, Florida Agricultural Experiment Station, pages 215–16. The trial of this substance against white ants is suggested in 1905 by the same

writer in the Florida Bulletin 79, page 313. Professor Gossard also mentions this method of destroying ants in the third issue of the JOURNAL, June, 1908, page 190. A solution possesses certain advantages over a dry powder. There is no danger for example of chickens picking up the particles if the former is employed. It is evident that this insecticide can be used to some extent at least against subterranean insects. More experiments are necessary to determine the limitations of this powerful insecticide along this line.

E. P. FELT

THE ECONOMIC ENTOMOLOGIST IN BUSINESS

By H. L. FROST, *Arlington, Mass.*

Each year as transportation facilities improve and natural products from all parts of the globe are assembled in one place, the problems of the economic entomologist are increased. With the changes of habitat of the various species of plant growth comes the unbalancing of Nature's control of both injurious and beneficial insects. Thus, the entomologist of today cannot be simply the man of scientific knowledge, but must debase his profession by combining his science with practical business in order to fill his position to the best advantage. Will he gain or lose by this change? His remuneration will be increased to a greater or less extent according to his business ability, but his glory of achieving honors by scientific research will be lessened because of his lack of time to carry on both branches of the work.

It is the purpose of this article to show in brief the great need of commercial economic entomologists. The profession is in its infancy and might be compared to the day of the medical profession when the patient was bled for every disease. Injurious insects have increased faster than remedies or natural enemies, and this is the problem to be overcome by our scientific and trained men. The value of all kinds of trees which suffer most from insect depredations has developed a hundred fold in the last decade. Owners everywhere are calling in vain for help to save trees which have required years to mature.

Fortunately, we have had a generation of scientific men, peers to none, who have devoted their lives to the study of insects. They have given and are giving us information, which is both complete and accurate. Our failure is our inability to make use of this research by securing and applying practical remedies. This is the field which offers unlimited opportunities to the present generation.

A proper preliminary training will be found of great service, but should be very broad in order to make a success of this work. Even

with this preparation one is, in reality, dependent to a great degree upon the specialists who are devoting their lives to the scientific study of insects. The average land owner is not equipped by either training or experience for carrying out the ideas of the economic entomologist. He requires a specialist who can accomplish the desired end. Unless injurious insects are checked our fruit trees, many of our ornamental trees, and, in New England, our forest trees, will be largely destroyed. The scientist, chemist, and trained workman, must all combine forces if the loss to agricultural interests is to be reduced.

No one should undertake a business of this description without supplementing his entomological training with a knowledge of some affiliated subject, such as Horticulture, Forestry, or Tree-surgery. His work of fighting insects, as a rule, covers only a short season, and must necessarily be carried on with the least possible delay. In the East, unfavorable weather conditions may deprive him of all his profits. On the other hand, very favorable conditions will give him most remunerative returns. Thus, he should make one of the above-mentioned branches the basis of his business, using his entomology as his speculative step toward the success of his enterprise.

As an illustration: A man owns a valuable orchard which is being stripped by the canker worm. He calls in a contractor, who recommends spraying with an arsenical poison. The season is so wet while the insect is feeding that it is impossible to do any spraying, and, consequently, the job is lost. If the contractor is equipped for horticultural work, he can benefit the orchard in other ways, even though he was unable to check the ravages of the insect. He will secure immediate results by pruning, fertilizing, and improving the general health of the trees, thus making them better able to resist insect attacks.

This is one instance where he has lost nearly his entire spraying season, which happens about once in seven or eight years. The strongest argument against his depending on entomological work alone is the necessity of his having skilled men. In fighting insects, a very high standard of trained laborers is required to obtain the best results. It is impossible to hold such men without giving them steady employment. To do this, work must be secured which can be held over, without injury to the tree, to be carried on at the convenience of these workmen. Tree-surgery or affiliated branches make this plan possible.

The business of caring for trees has made a tremendous advancement in the last ten years, but we still have many problems to solve. The least progress has been made in handling the various insects, as

there are still many pests which cannot even be suppressed. Chemicals used for spraying purposes very often act differently under different climatic conditions. Whether this is due to chemical changes in the poisons or to varying pathological conditions seems to be unknown. For example, tests have been made of nearly every brand of arsenate of lead (supposed to be a perfectly safe poison) and in each case, under certain conditions, burning of the foliage has resulted. If our most perfected remedy cannot be depended upon under all conditions, even when applied by trained men, the great necessity of advancement is readily apparent. This can be assured only by the entrance into business of economic entomologists.

MUST THE CALYX CUP BE FILLED?[1]

By M. V. Slingerland, *Cornell University*

More than a decade has elapsed since I studied the codling-moth and monographed the then existing knowledge of the insect in Bulletin 142 of the Cornell Agricultural Experiment Station. Since then I have closely followed the excellent work done, both in the East and the far West, by which much new information has been gleaned regarding the life-history and methods of controlling this pest. But I was hardly prepared for the accusations that Eastern entomologists were lax and not up to date in their advice to their constituents, as set forth in the article entitled "Filling the Calyx Cup," in the June, 1908, number of this Journal.

Fortunately I had been making some photographs of the calyx ends of developing apples for my class work when the above article appeared. The pictures at A, A, A, A, B and C on the plate well illustrate the outer and inner calyx cavities, which are separated by the ring of stamens, with the large fleshy pistil extending up through the center. The bases of these stamens set very closely together and come up close around the pistil. I was also surprised to find that even after their tips had withered and the calyx lobes had closed in, the stamens remained fresh and plump at the base, and around the pistil, and thus still formed a partition or wall between the two cavities, as shown at C. In fact so tight a barrier did the stamens form between the two cavities that I became a "doubting Thomas" as regards the assertions of some entomologists that it was absolutely necessary to drench a tree with a spray sufficiently forceful to drive the

[1]Contribution from the Entomological Laboratory of Cornell University.

poison into the lower calyx cavity in order to obtain satisfactory results against the codling-moth.

After reading the assertive and accusing article above mentioned, on June 27, I went to Nature for the facts as regards the feeding habits of the young codling-moth larvæ. Do they feed any in the upper calyx cavity after squeezing through between the closed calyx lobes? Or do they go on down through the closely set row of stamens into the lower calyx cavity for their first meals? The answer to these questions would determine if it was necessary to drive the poison spray into the lower calyx cavity.

I found that in every case where the young larva had entered the apple at the calyx end it had stopped to feed in the outer calyx cavity. Furthermore, the larva had fed in the outer cavity for several days, or through the first larval stage. The only ones I found going farther into the apples had a head diameter of about .54 mm., which corresponds almost exactly to Simpson's recorded diameter for the head of codling-moth larvæ in the second stage. At D on the plate is shown such a larva in the second stage that was just going into the lower calyx cavity. It had fed quite extensively around in the upper cavity, partly on the fleshy stamens, and a few pellets of its excrement had dropped into the lower cavity. I was unable to obtain any evidence that the larvæ worked their way into the lower calyx cavity without first taking several meals in the outer cavity. Several other Eastern entomologists with whom I have discussed these facts have made similar observations. The young codling-moth larvæ may have different feeding habits in recently-set apples in the far West, but thus far I have not seen any definite facts or pictures to prove that they do not first stop to feed in the outer calyx cavity when they enter young apples at this point.

Remarkable results have been recorded from thorough, drenching, forceful arsenate of lead sprays in the West, perhaps better results than Eastern fruit-growers usually get, but is it not due more to the thoroughness and method of application than to the 200 pounds of pressure which is supposed to be necessary to drive the spray into the lower calyx cavity? All entomologists and many progressive fruit-growers now understand the great importance and necessity of the application of a poison spray for the codling-moth soon after the petals have fallen and before the calyx lobes close up. But there still remain many apple growers who do not spray thoroughly enough or direct the spray properly into the calyx cups, and it is not because of the laxity or proper advice of entomologists. Such is human nature.

Finally, from recent codling-moth literature and from the facts I

have been able to glean from Nature (as illustrated in the figures on the plate), I am not yet convinced that it is wise to assert that a fruit-grower must drench his trees with arsenate of lead only and that the spray must be applied with a force necessary to drive it into the lower calyx cavity of young apples. The evidence submitted in Bulletin 131 of the Colorado Experiment Station to show that fruit trees are being poisoned and killed by excessive use of poison sprays should be seriously considered by both entomologists and fruit-growers in alkaline regions. Under similar conditions cannot just as satisfactory results be obtained against the codling-moth with either Paris Green or arsenate of lead applied as a fine spray in moderate quantities evenly over the trees, at about 100 pounds pressure, if the spray is properly directed downward into the open outer calyx cavities of the recently-set apples? I have not yet seen sufficient evidence to warrant entomologists in answering this question in the negative.

THE ARMY WORM AT DURHAM, NORTH CAROLINA

By Z. P. Metcalf, Assistant Entomologist, State Department of Agriculture, *Raleigh, N. C.*

The occurrence of the Army Worm (*Heliophila unipuncta*) in destructive numbers at Durham, in the east central part of this state, on August 9, 1908, presented three interesting points:

(1) The occurrence of this species so far south and so far east in the state; (2) its occurrence so late in the season; and (3) the per cent of worms parasitized.

Our office records covering the last eight years show that this insect does not occur in destructive numbers very far east of the mountains. It was reported as being injurious in May, 1907, from the extreme southwestern portion of the state.

Although the Army Worm has been reported as being destructive as late as the last of September, it rarely occurs in injurious numbers after the last of July.

As is usual during such outbreaks, large numbers of Tachina flies (*Winthemia quadripustulata*) were to be found in the fields laying eggs on the worms. With the intention of making a more careful study of these parasites 491 larvæ were brought back and placed in cages. The following data gleaned from the records of these cages are presented as being of some interest. Of the 491 larvæ, 442 were infested with the eggs of the dipterous parasite, *Winthemia quadripus-*

Plate 7

Must the Calyx Cup be Filled?

tulata, leaving only 49 larvæ, or 10 per cent of the whole number, uninfested; yet 61 larvæ were able to pupate. From these 61 pupæ, however, only 7 adult moths emerged, showing a total mortality among the Army Worm from larva to adult of 98.6 per cent. And since 90 per cent of the larvæ were infested with the eggs of this parasite, it would seem to indicate that, in this case at least, the parasitic fly was decidedly the most important factor in causing the high mortality of the Army Worm. In a few cases it was found that where only a single parasitic egg was attached to a larva, that the host was able to complete its transformations.

The greatest number of parasitic eggs observed on a single larva was 12, with an average of 3 for the entire number (442) infested. The 442 infested larvæ yielded 709 parasitic puparia, or an average of nearly two for each infested larva. The 709 puparia yielded 556 adult parasites. The greatest number of adult flies from a single Army Worm was four. These figures show that the mortality with the parasitic fly from egg to puparium was 52 per cent, and from puparium to adult 22 per cent, making a total mortality from egg to adult of 73 per cent.

This shows that the tendency would be for the fly to continually gain in relative numbers, owing to the lighter mortality, and easily accounts for the complete subjugation of the Army Worm in normal years by this one natural enemy. No other parasites were found in the course of these experiments.

NOTES ON THE HEN FLEA (XESTOPSYLLA GALLINACEA)

By Glenn W. Herrick

During the summer of 1907 the ground beneath one of the dwelling houses on the campus of the Mississippi Agricultural College became infested with fleas to such an extent that the occupants were greatly annoyed by these pests. On examination I found that two species were present beneath the house, namely, the hen flea and the dog flea. The house, of course, stood on brick pillars some distance above the ground, and thus gave opportunity for hens to go under, where they would lay eggs and rear chickens. Dogs and cats also had free access to the space beneath the house. To secure relief the space under the house was treated with a thorough dusting of slacked lime and nothing more was heard from the occupants until the summer of 1908, when the fleas again became troublesome.

On investigation a hen was found sitting beneath the house and she and her nest were literally alive with the hen flea, *Xestopsylla gallinacea*.

I do not mean to say positively that this flea was annoying the occupants of the house, for no specimen of this particular species was ever found by me in the rooms. In fact, I was unable to get hold of any of the specimens in the house that were actually causing the trouble.

The fleas on the hen were confined to the face, ear lobes and wattles. These parts of the fowl were almost black with them. By actual count there were 164 on the right wattle, 65 on the right ear lobe, and by estimate, 200 or more on the right side of the face. The pests stood at right angles to the surface, with their heads embedded in the skin, nor were they at all easy to remove. They could not be brushed off nor scraped off with a knife without hurting the hen. I removed some with tweezers, but even with these instruments they came off with difficulty.

We placed the fowl in a large box containing some sawdust and kept her there several days, during which time she managed to free herself from a good many by scratching her head with her toes, and I suspect some of the older, engorged females dropped off to deposit eggs.

I dissected some of the engorged females and found they contained, apparently, well developed eggs. In one I found three white oval-shaped eggs. In another I found five. On June 22 I placed two engorged fleas in each of three vials. On the morning of June 23 (8.30) I found five eggs in vial *a*, five eggs in vial *b*, and three eggs in vial *c*. The eggs were white, oval and considerably longer than broad. They measured from .35 to .4 mm. in length. It appeared so easy to obtain the eggs that I thought a more extended observation might be worth while.

Accordingly, on the morning of June 23 I placed one large, apparently engorged female flea in each of fifteen vials, to ascertain their egg laying capacities. To my surprise and gratification, eggs were obtained in every case but one and in most cases the larvæ hatched readily, as shown by the following table:

OVIPOSITION RECORD OF HEN FLEA.

June 23.	June 24.	June 25.	June 26.
Fleas placed in vials.	No. eggs.	No. eggs	No. larvae hatched.
Vial a.	2	2	2
Vial b.	2	2	1
Vial c.	1	1	0
Vial d.	3	3	3
Vial e.	4	4	0
Vial f.	7	7	5
Vial g.	3	3	0
Vial h.	1	1	1
Vial i.	4	4	1
Vial j.	4	4	2
Vial k.	5	5	3
Vial l.	4	4	1
Vial m.	2	2	0
Vial n.	1	1	0
Vial o.	3	3	2

It will be seen from the foregoing table that the fleas laid all of their eggs on the day following their placement in the vials and that the larvæ hatched within forty-eight hours after the eggs were deposited. At 9.30 a. m. on June 26 I found most of the larvæ just wriggling out of the egg shells. Some had not yet gotten clear of the shells.

The larvæ were white, very active and from 1.5 mm. to 1.8 mm. in length. They were nearly of the same diameter throughout, with the thorax slightly larger.

I placed them in separate vials along with sawdust, feathers and filth, but, owing, very likely, to unfavorable conditions of moisture and temperature, none of them developed.

Professor Osborn in Bulletin 5, n. s., of the U. S. Bureau of Entomology, p. 145, quotes the observations of Judge Johnson on the life-history and habits of this flea. Judge Johnson says regarding them that "the females bury themselves in the skin of their victims. From the first they hold on with such tenacity that no ordinary brushing will remove them. It seems to be at this stage in their existence that impregnation takes place. The males now are often seen in copula with them and so remain apparently for days, or until the tumefac-

tion of the skin excited by the embedded female closes around her so as to shove them off. Here ends about all actually known of their history." From my observations this account is very probably accurate, except the latter part. I found the males present on the head of the fowl, but did not actually observe them in copulation with the females, although fecundation must have taken place under these conditions. So far as my observations go, however, no tumefactions of the skin of the fowl take place. Judge Johnson farther says: "From analogy we may infer that the period of gestation being completed, the gravid female lays her eggs in this well prepared nidus, or more particularly that they remain or are hatched in her distended stomach, after which they crawl out and drop to the ground."

From the ease with which the females were induced to lay eggs in the vials, I believe they simply drop off when engorged, like a cow tick, and lay their eggs among the debris in the nests of the fowls. At no time was there a tumefaction of the skin or a so-called nidus formed. It seems to me that Judge Johnson must have ascribed the disease known as "the wart disease" to this flea or possibly confused it with that of *Sarcopsylla penetrans*.

Scientific Notes

Toxoptera graminum Rond. has been found very generally distributed over Minnesota during the last summer, wherever wheat is grown, and eggs which were collected out of doors in the early spring near St. Anthony Park hatched in due season, showing that the species can survive our winters, or at least, did survive last winter. Insectary work upon this insect shows it to be much more prolific than *Macrosiphum granaria*.

Three species of locust, namely *M. femur-rubrum*, *M. atlanis* and *M. bivittatus*, have been locally quite destructive in Minnesota this season.

In work with stalk borers, Genus *Papaipema*, during the summer several species have been found to be common in Minnesota, among them *P. furcata* has injured hundreds of young ash in nursery rows by boring in the center, and so weakening the tree that a slight wind breaks it.

F. L. WASHBURN, *St. Anthony Park, Minn.*

NOTES AND DESCRIPTIONS OF SOME ORCHARD PLANT LICE OF THE FAMILY APHIDIDAE

By C. P. Gillette

(*Continued*)

The Green Peach-Aphis, *Myzus-persicae*, Plate 8, Figs. 4 to 11.

Some of the More Important Literature

Aphis persicæ Sulz., Kennzeichen Insecten, p. 105, 1761.
Aphis dianthi Schr., Fauna Boica, II, 1801.
Aphis dianthi Schr., Monographie der Fam. Pflanzenlause, Kalt., p. 42, 1843.
Rhopalosiphum dianthi Schr., Die Pflanzenlause, Koch, p. 42, 1857.
Myzus persicæ Sulz., British Aphides, Buckton, I, p. 178, 1876.
Megoura solani Thos., Eighth Rep. Ent. Ill., p. 73, 1879.
Myzus persicæ Sulz., Thomas, Eighth Rep. Ent. Ill., p. 76, 1879.
Siphonophora achyrantes Monell, Bull. U. S. Geol. Sur. Vol. V, No. 1, p. 18, 1879.
Myzus malvæ Oest., Geol. Sur. Minn., 14th Rep., p. 31, 1886.
Myzus persicæ Sulz., Taylor, Jour. Ec. Ent., I, p. 83, 1908.
Myzus persicæ Sulz., Gillette and Taylor, Bull. 133 and 134, Colo. Exp. Sta., 1908.

This louse has the widest range of food plants of any species known to me, and it is peculiar in possessing cylindrical cornicles in the spring migrant and distinctly swollen cornicles in the return migrant and the male in the fall. This difference in cornicles, the wide range of food plants, and the remarkable variations in color, together with only a partial knowledge of the life-history by the different writers, fully explain how it is that this louse has been described under so many different names in Europe and America.

Young Stem-Mother—before first moult; Plate 8, fig. 4.

Specimens from peach and native plum, Fort Collins, Col., March 25, 1908.
Color dull and rather dark green, becoming lighter, tinged with yellowish, as it feeds and grows; head, legs and antennæ somewhat dusky brown in color; on the middle of the head a pale median line; eyes dark red.

MEASUREMENTS OF SIX STEM-MOTHERS THAT HAD GROWN LITTLE IF AT ALL, RAN AS FOLLOWS:

Body.	Antenna.	Antennal Joints.	
		Left Side.	Right Side.
.72mm	.85mm	5	5
.65	.85	5	6
.61	.85	5	5
.62	.85	5	5
.65	.84	..	..
.72	.85	..	..

A larger specimen that possibly had shed once measured .80 mm., and the antenna .45 mm.; joints of antenna 6 on each side; others, as shown above, were mostly 5-jointed on each side. The .80 mm. louse began to show the carneous color, which usually appears after the first molt. Cornicles short, keg-shaped, being slightly bulged in the middle; length .03 mm.; antenna hairless; 3d joint about equal to 4 and 5 combined; body smooth, free from hairs and without distinct markings.

Adult Stem-Mother—Plate 8, fig. 5.

Specimens taken in peach blossoms, Fort Collins, Col., March 30, 1907.

Length of body varying little from 1.70 mm., width 1 mm.; length of antenna .80 mm.; cornicles .14 mm., cylindrical or slightly clavate; antennal joints: III, .33; IV, .16; V, .13; VI, .17 mm.; 5th joint barely larger than base of 6th; no indication of joint being divided into two; one sensorium near distal end of 4th joint, and the usual cluster on the 5th; color pale green, more or less washed and mottled with light salmon. In many cases the red color predominates, and in others the green. Cornicles rather strongly converging, slender, slightly larger at base, black at extreme tips; legs very pale, with distal ends of tibiæ and tarsi black; antennæ very pale, a little dusky towards distal ends; no thoracic or abdominal tubercles, antennæ on moderate though well developed tubercles; cauda slightly curved upwards and with velvety appearance, due to the surface being densely set with minute points; beak barely attaining hind coxæ, and black at extreme tip.

Apterous Viviparous Female, Second Generation—Plate 8, fig. 7.

Specimens taken from peach leaves, Fort Collins, Col., September 16, 1908.

General color a very pale yellowish green without black markings, even upon the legs; eyes dark red. These females usually exhibit one or more small red dots on the abdomen, due to the colors of the eyes of the embryos. General shape of the louse rather long and tapering posteriorly; surface of the body finely reticulated; length of body 1.86 and greatest width 1 mm.; antennæ 2.09 mm.; joints: III, .43; IV, .31; V, .57; VI, .10; VII, .88 mm.; cornicles .60 mm.; hind tibiæ 1 mm.; antennæ upon rather strong frontal tubercles; first joint of the antennæ with a prominent angle or gibbous enlargement; prothorax without lateral tubercles; a few scattering hairs upon the body, most of which are capitate. The cornicles are slender, nearly uniform in diameter throughout, slightly swollen on the inner margin near the distal end, at which point they curve slightly outward.

The summer apterous females upon various vegetable and greenhouse plants differ from the spring form by being pale yellowish in color and having the median and two dorsal longitudinal green stripes upon the abdomen obscure or wanting.

Spring Migrant Plate 11, fig. 8, Plate 6, figs. 11, 12

The spring migrant differs from the fall migrant described below by being more green in ground color, having the dark markings blacker and more extensive, the cauda and cornicles being black or blackish, and, most important of all, the cornicles are cylindrical

Winged Viviparous Female, Fall Migrant—Plate 8, fig. 9, Plate 6, figs. 13, 14.

Specimens taken at Fort Collins, Col., October 13, 1906, from plum, peach and cherry trees.

Head, entire thorax above, mesothorax below, distal portions of all femora and tibiæ, the tarsi, antennæ and a large spot on the pleurum beneath the insertion of the fore wing black or blackish; abdomen pale yellow or greenish yellow, with a large dusky brown patch upon the dorsum of segments 4, 5 and 6, and often extending upon segments 3 and 7; spots of a similar color upon the lateral dorsal margins of segments 2, 3 and 4; the metasternum, genital plates, middle and hind coxæ, cornicles, style, distal half of beak, and sometimes two or three spots on either side of venter, dusky brown; eyes very dark red; stigma of wing slightly dusky; third joint of the antennæ lighter than other parts; lateral tubercles of thorax wanting, or appearing as very small points; length of cauda .14 mm.; cornicles distinctly constricted in basal half, giving them the form of a ball club. Joint 3 of the antenna with 10 to 12 circular sensoria in a single row. No others except the regular ones on joints 5 and 6; see Plate 6, fig. 14.

MEASUREMENTS IN MILLIMETERS OF FOUR NORMAL SPECIMENS

Body.	Antennæ.	Wing.	Cornicles.
1.8	2.2	3.7	.36
2.1	2.7	4.0	.43
1.8	2.3	3.6	.38
2.0	2.3	3.7	.41

MEASUREMENTS OF ANTENNAL JOINTS IN MILLIMETERS

Jt. 1.	Jt. 2.	Jt. 3.	Jt. 4.	Jt. 5.	Jt. 6.	Jt. 7.	
.08	.06	.54	.42	.32	.16	.58	
.08	.06	.52	.40	.30	.14	.56	
.08	.06	.52	.38	.30	.16	.56	
.10	.06	.52	.40	.32	.14	.56	
.085	.06	.525	.40	.31	.15	.565	Averages.

Oviparous Female—Plate 8, fig. 10 and Plate 6, figs. 16 and 17.

Specimens from peach and native plum, Fort Collins, Col., November 2, 1906.

The young, when first born, are green with red eyes, but soon change as they grow to bright flesh or even salmon-colored apterous individuals, with distal half of antennæ, tarsi and extreme tips of cornicles black or dusky. The cornicles of these apterous females, when resting quietly, usually converge strongly towards their tips, lying close to the sides of the body, and each is bent distinctly outward near the distal end, where they are usually a trifle thicker than near the proximal end. Fully grown examples are

bright salmon red in color. The antenna is about two thirds as long as the body, or approximately 1.45 millimeters; length of body 1.70 to 2 mm.; cornicles .33 mm. I have not been able to see any sensoria upon 3d joint of antenna, but about 25 small circular sensoria occur upon each hind tibia. See Plate 6, figs. 16 and 17.

The eggs are deep green when first laid but become shining black in a few days. They are .66 mm. long by .33 mm. broad and are deposited chiefly in the axils of the buds. See Plate 8, fig. 11.

Male.

Taken on peach leaves by L. C. Bragg, Ft. Collins, Colo., November 4, 1908.

Colors practically the same as in spring migrant but with the black or blackish markings, at least in some specimens, more extensive; cornicles dusky to black, moderately swollen, as in fall migrating female. Lengths: Body, 1.85 mm.; wing, 3.20 mm.; cornicles, .34 mm.; antenna, 2.30 mm. Joints: III, .56; IV, .49; V, .40; VI, .14; VII, .60 mm. Numerous small circular, moderately tuberculate sensoria upon joints 3, 4 and 5. See Plate 6, fig. 15. Frontal tubercles and 1st antennal joints are rather strongly swollen.

The male is a fall migrant, going to the trees from the summer host plants, and is not the offspring of the female fall migrant. The latter gives birth to the apterous oviparous females only.

The Black Cherry Louse, *Myzus cerasi* Fab.; Plate 8, Figs. 1, 2, 3.

Some of the More Important Literature

Aphis cerasi Fab. Syst. Ent., p. 734, 1822.

Aphis cerasi Fab. Kaltenbach. Mon. Fam. Pflanzenlause, p. 45, 1843.

Aphis cerasi Fab. Koch. Die Pflanzenlause, p. 87, 1857.

Myzus cerasi Fab. Buckton, British Aphides, V. I, p. 174, 1876.

Myzus cerasi Fab. Fitch, Cat. Homop. N. Y., 1851 (Lintner's 9th Rep. Ent. N. Y., p. 405).

Myzus cerasi Fab. Thomas, Ent. Ill. 8th Rep., p. 75, 1880.

Myzus cerasi Fab. Oestlund, Aph. of Minn., p. 73, 1887.

Myzus cerasi Fab. Weed, C. M., Bull O. Expt. Sta. Tech. Ser., V. I, No. 2, 1890.

Myzus cerasi Fab. Theobald. Rep. Econ. Zool., p. 48, 1908.

This coal black louse is the only aphid of any importance as a pest upon the cultivated cherry in Colorado. It continues upon cherry foliage throughout the season and neither my assistants nor myself have been able to discover it upon any other tree or plant.

EXPLANATION OF PLATE

PLATE 8. Figs. 1-3 *Myzus cerasi*; 1, adult, apterous viviparous female; 2, winged viviparous female; 3, winged male. Figs. 4-11 *Myzus persicæ*; 4, young stem mother; 5, adult stem mother; 6, recently hatched young of stem-mother; 7, apterous viviparous females, second generation; 8, spring migrant; 9, winged viviparous female, fall migrant; 10, oviviparous female; 11, egg. Figs. 12-15 *Hippodamia convergens*; 12, adult; 13, larva; 14, pupa; 15, cluster of eggs. M. A. Palmer artist. Original plate in Bul. 133, Colo. Exp. Station.

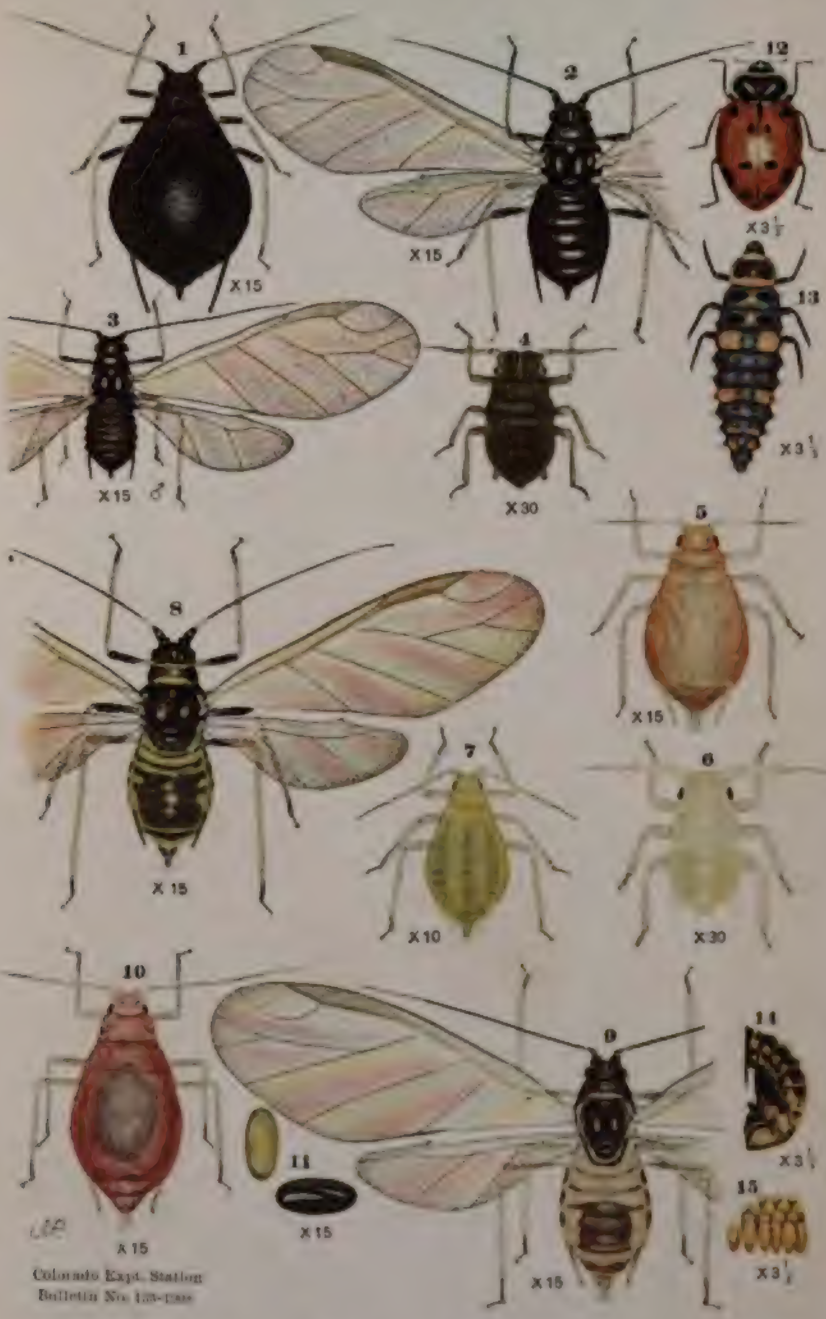

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PLATE II PLANT LICE

Adult Apterous Viviparous Female—Plate 8, fig. 1.

From specimens taken at Fort Collins, April 18, 1908.

Color deep shining black with tibiæ, anterior femora and basal portion of antennæ beyond 2nd joint, pale dusky yellow: surface of body finely rugulose; measurements vary little from the following: Body 1.90 mm. by 1.40 mm.; antennæ 1.25 mm.; cornicles .50 mm.; cauda short, conical, .17 mm. in length. Joints of antennæ: III, .36; IV, .21; V, .18; VI, .10; VII, .25 mm. The cornicles taper a little towards tip and near the end are distinctly constricted and turned outward and have a moderate flange at end. Body and antennæ without hairs, and the hairs on legs short and weak; no tubercles upon thorax or abdomen, except in some specimens upon joint 7 of the abdomen, as shown in colored figure. When at rest the cornicles usually converge strongly, almost touching at their distal ends. Antennæ upon distinct frontal tubercles which are moderately swollen, as are the first antennal joints on the inner side.

Winged Viviparous Female.

Described from specimens taken at Fort Collins, September 28, 1907.

General color deep black, with the tibiæ and basal portions of the femora pale yellowish in color; prothorax with slight lateral tubercles or none; cornicles cylindrical, black, with moderate flange at distal end and varying little from .37 mm. in length; cauda black, up-turned, tail-like, about as long as hind tarsus; length of body varying little from 1.40 mm.; antenna a little longer than body, averaging about 1.70 mm.; joints measure approximately as follows: III, .50; IV, .31; V, .24; VI, .13; VII, .43 mm. Wings about 2.80 mm., stigma of wing blackish; venation normal; third joint of antenna with about 14 moderately tuberculate sensoria in a broken row and none upon joint 4.

Winged Male.

Specimens taken from sour cherry, College orchard, Fort Collins, Col., November 17, 1907.

Length 1.30 mm.; general color deep black, the abdomen a little lighter than the other portions of the body and in some specimens appears to be dusky brown, with narrow transverse bands upon the segments between the cornicles, and back of them it may be entirely black; eyes very dark red; tarsi and distal portions of tibiæ and femora black; prothorax with lateral tubercles weak or lacking; wings hyaline, stigma a little dusky brown, nervures dark brown; length of antenna 1.70 mm.; joints of antenna: III, .40; IV, .28; V, .23; VI, .11; VII, .50 mm.; length of wing 2.50 mm.; length of cornicles .23 mm., cylindrical and black. Joints 3, 4 and 5 are strongly tuberculate, with a large number of similar circular sensoria. The sensoria are most abundant on joint 3. Antennæ on distinct frontal tubercles that are slightly swollen, first joint distinctly gibbous.

Aphis bakeri Cowen

Some of the More Important Literature

Aphis bakeri[1] Cowen, Bull. 31, Tech. Ser., Colo. Ex. St., p. 118, 1895.

Aphis cephalicola Cowen, *ibid.*, p. 118.

Aphis bakeri, Hunter, Aphid. N. A., Bull. 60, Ia. Ex. St., pp. 93, 132, 1901.

Aphis cephalicola, Hunter, *ibid.*, pp. 95, 132.

Aphis bakeri, Sanborn, Ks. Univ. Sci. Bull., Vol. III, No. 8, pp. 251, 255, 1906.

Aphis cephalicola, Sanborn, *ibid.*, pp. 251, 256.

Aphis bakeri, Gillette & Taylor, Bull. 133, Colo. Ex. St., p. 28, 1908.

Mr. Cowen collected this louse from stems of red clover (*Trifolium pratense*), and from the heads of white clover (*T. repens*). During the past three years we have taken this louse many times in the vicinity of Fort Collins, Denver, Delta, Paonia, Montrose, Grand Junction and Rocky Ford, Colorado. It occurs early and late in the season in greatest numbers upon the stems of red clover close to the ground, where, in mild seasons at least, it doubtless spends the winter as viviparous females and young. It has lived and done well all winter upon clover plants brought into the laboratory by Mr. Bragg.

As I have succeeded, with the aid of good observers, in working out the life history of this louse quite fully, a list of our written records for Colorado might be worth printing. The additional observations that we have made, but which have not been written down, far exceed the written records which follow in chronological order, disregarding the year:

March 22, '07, Fort Collins, apterous and alate females and alate males, on red clover (insectary).—Bragg.

April 2, '08, Fort Collins, apterous females on *Bursa B.-pastoris*.—Bragg.

April 11, '08, Eckert, stem-mothers, young to fully grown, also some 3d generation lice half grown on pear buds.—Gillette.

April 13, '08, Delta, stem-mothers, small to fully grown, many examples on pear and apple buds.—Gillette and Weldon.

April 26, '08, Fort Collins, alate and apterous females, on apple (insectary).—Gillette.

May 9, '07, Fort Collins, apterous and alate females, on sweet clover.—Gillette.

May 15, '07, Fort Collins, alate and apterous females on red clover.—Gillette.

[1]It is not improbable that Oestlund's *A. trifolii* was an immature apterous example of this species, but *trifolii* was given as a root louse, which bakeri is not; neither is it pulverulent, and the mere statement that it was a pink louse, quite similar in other respects to *A. middletoni*, does not seem to be a characterization sufficient to identify it

May 21, '08, Delta, apterous and alate females on apple.—Gillette and Weldon.
May 22, '08, Cory, stem-mothers and alate females, on apple and pear.—Gillette and Weldon.
May 22, '08, Austin, Delta County, apterous and alate females, on pear and apple.—Gillette.
May 26, '08, Rocky Ford, pupæ and winged females on apple.—Bragg.
June 8, '08, Fort Collins, apterous and alate females on *Crataegus occidentalis,* very abundant.—Gillette.
June 22, '08, Fort Collins, apterous and alate females on red clover.—Gillette.
July 8, '08, Fort Collins, apterous females on apple.—Gillette.
July 10, '08, Grand Junction, alate females on apple, very scarce.—Weldon.
July 12, '08, Delta, alate females, on apple.—Weldon.
Aug. 3, '98, Fort Collins, apterous and alate females on red clover.—Gillette.
Aug. 16, '08, Fort Collins, apterous females on apple sprouts.—Gillette.
Aug. 21, '08, Paonia, apterous and alate females, on red clover.—Weldon.
Sept. 28, '08, Fort Collins, apterous and alate females on red clover.—Gillette.
Oct. 1, '08, Grand Junction, return migrants and young oviparous females, on apple and pear.—Weldon.
Oct. 6, '08, Delta, return migrants, male and female, on apple.—Weldon.
Oct. 14, '08, Fort Collins, apterous and alate females on red clover.—Gillette.
Oct. 22, '06, Fort Collins, apterous and alate females on red clover.—Bragg.
Oct. 26, '08, Delta, return migrants, male and female, and oviparous female, also eggs, on apple.—Weldon.
Oct. 29, '06, Fort Collins, alate males, and apterous and alate females on red clover.—Bragg.
Oct. 31, '06, Fort Collins, alate and apterous females on red clover.—Bragg.
Nov. 4, '08, Delta, return migrants, male and female, and oviparous females, on apple.—Weldon.
Nov. 8, '08, Fort Collins, return migrants, male and female, and oviparous females, on *Crataegus occidentalis.*—Miss Palmer.
Nov. 26, '06, Fort Collins, alate males and females and apterous females, on red clover.—Bragg.

I have also received examples of this louse from Mr. J. T. Monell that were labeled "Manhattan, Kansas, 8–27–'08, Ainsley; taken on red clover"; and specimens from Mr. J. J. Davis marked "Urbana, Illinois, 3–11–'08; on clover, in insectary."

From our records and observations there seems to be no doubt but what this louse spends the winter chiefly in the egg stage upon apple,

pear and *Crataegus;* but also, to some extent, upon the clovers, and in some cases upon *Bursa,* as alate apterous and viviparous females and young, when given sufficient protection and when the weather is not too cold. The stem females hatch very early, so that many are fully grown and giving birth to young by the time the apple buds begin to open. The fully developed stem-mother is usually rather dark red in color.

Winged spring migrants begin to appear in considerable numbers in the second generation, and are abundant in the third generation. By June 30, they have nearly all left the trees, but small colonies do sometimes continue throughout the season upon the apple. The spring migrants go to the clovers as their summer host plants, and the female fall migrants begin returning to the apple, pear and *Crataegus* about the last of September. A little later the alate males which develop upon the summer food plants, follow to fertilize the apterous oviparous females, which are the offspring of the fall migrants. The oviparous females begin to deposit eggs about October 20. Mr. George P. Weldon reported finding the first eggs at Delta, Colorado, on October 26, and states that they are at first green like the eggs of *Aphis pomi,* but soon become black.

The striking characters which readily separate this species from others that infest the apple and pear are the light yellow to pink color of the body in the larvæ and apterous adults; the minute dark specks which occur upon the dorsum of the apterous forms, both larvæ and adults; the large dark green to blackish quadrate patch upon the dorsum of the alate forms; and the short cornicles. In case of the larvæ and apterous lice there is also a light area at the base of each cornicle which is often quite conspicuous.

During last spring this louse was the most abundant species upon the apple and pear trees on the western slope in Colorado.

Adult Stem-Mother—Plate 9, figs. 1 and 5.

Specimens taken at Eckert, April 11, 1908.

Ground color dark green at first, and more or less streaked and mottled with deep red both above and below, but there is much more red on the dorsal than on the ventral side; cornicles and cauda very short and pale yellowish green, almost colorless; legs and antennæ pale green, with distal ends of the tibiæ and antennæ and the tarsi black; general form rather long and tapering posteriorly when just mature; old lice more robust and nearly all dark red, even legs, prothorax and antennæ in some cases; length of body about 1.90 mm.; antenna .70 mm.; joints: III, .37; IV, .13; V, .11 mm. There is some variation in length of antenna and in some cases joint 3 is divided into two making 6 joints. In some cases there will be 5 joints in one antenna and 6 in the other on the same louse. Near the end of joint 3 (or

4 if 6-jointed) is the large sensorium which commonly occurs upon joint 5 in the aphididæ; length of cornicle .11 mm., stout, tapering, largest at base.

Apterous Viviparous Female—Plate 9, fig. 2.

Specimens from clover, Ft. Collins, June 23, 1908.

General color pale yellowish or greenish yellow, with a slight tinge of pink or light orange, especially in the region of the cornicles; upon the dorsum a sprinkling or mottling of dark green or rusty brown specks irregularly distributed, and in some the faint dusky specks at the bases of the abdominal hairs also show; in some of the older individuals, the dark markings form a transverse dash upon the segments posterior to the cornicles, and joints 1 and 2 of the antennæ and the dorsum of the head are often blackish. The large yellow to pale orange blotches surrounding the cornicles are not as sharply outlined as in the larvæ and pupæ; cauda and cornicles entirely concolorous with body, not marked with black; distal half of antenna more or less blackish; distal ends of all tibiæ, the tarsi and tip of beak black; eyes appearing black but really very dark red; length of body 1.70 to 2.20 mm.; length of antenna .90 to 1.10 mm.; cornicles .11 to .14 mm.; joints 3 and 7 of antenna sub-equal, either being a trifle longer than the other.

Pupa.

Specimens taken with the preceding apterous females.

The pupæ in all stages are decidedly pink in color and the deeper color markings that are usually deep green in case of the apterous females are usually reddish here, but may be dusky, the darkest color coming next to the well defined yellowish or pale orange blotches surrounding the cornicles. The body generally is quite strongly tinged with pink; the dusky specks so conspicuous upon the larvæ are entirely absent, as are all the heavier dark markings of the adult forms.

Alate Viviparous Female—Plate 9, figs. 3 and 6.

Specimens from Delta, Colorado. Sent by Mr. Weldon May 23, 1908.

Head, thorax, antennæ, tarsi, distal ends of femora and tibiæ, sternum of mesothorax, anal plates and coxæ deep shining black; the middle portion of the dorsum of segments 3, 4 and 5 and transverse bands on segments 6, 7, and 8, small spots and dashes upon joints 1 and 2 and the lateral margins of joints 2 to 7 also black or blackish; abdomen light olive to yellowish green; cornicles short, cylindrical or somewhat tapering, dark green to black in color and with moderate flange; cauda of moderate length, green at the base, black about the margins, upturned; lateral tubercles of prothorax moderate in size; strong tubercles upon lateral margins of abdominal segments 3 to 7, helping to make the margins of the segments prominent and well defined; length of body 1.75 mm.; width .75 mm.; length of antenna 1.12 mm.; joints: III, .30; IV, .19; V, .16; VI, .10; VII, .30 mm.; length of wing 2.50 to 3 mm.; hind tibiæ, .90 mm.; cauda, .11 mm.; cornicles, .11 mm.; third joint of antenna strongly tuberculate on inferior surface with about 24 circular and oval sensoria; joint 4 with about 6 sensoria in middle portion; joints 3 to 7 quite strongly transversely wrinkled; wing venation normal; 2nd fork about equally distant from 1st fork and the margin of the wing.

Apterous Oviparous Female—Plate 9, fig. 4.

Specimens taken by Mr. Geo. P. Weldon at Delta, Colo., October 26, 1908, on leaves of apple trees.

The general color varies from a dull green to bright pink or even dark salmon, with the numerous minute dusky spots characteristic of this species. The dorsal surface is more or less mottled in many of the specimens due to the ova which show through. The head is noticeably dusky brown in color; anal plates and a transverse dash on the eighth abdominal segment, the tarsi, distal ends of the tibiæ, eyes, and distal half of the antennæ black or blackish; antenna 6 or 7-jointed; cornicles slightly dusky; color beneath about the same as above except that it is a little lighter; length of body 1.35 mm.; antenna, .51 mm.; joints: III, .10; IV, .07; V, .08; VI, .07; VII, .12 mm.; no sensoria on antenna except the usual ones at the distal ends of joints 5 and 6 (or 4 and 5 in those that are 6-jointed). When there are but 6 joints, joints 3 and 4 are united.

Winged Male.

Specimens from red clover, Ft. Collins, November 2, 1906.

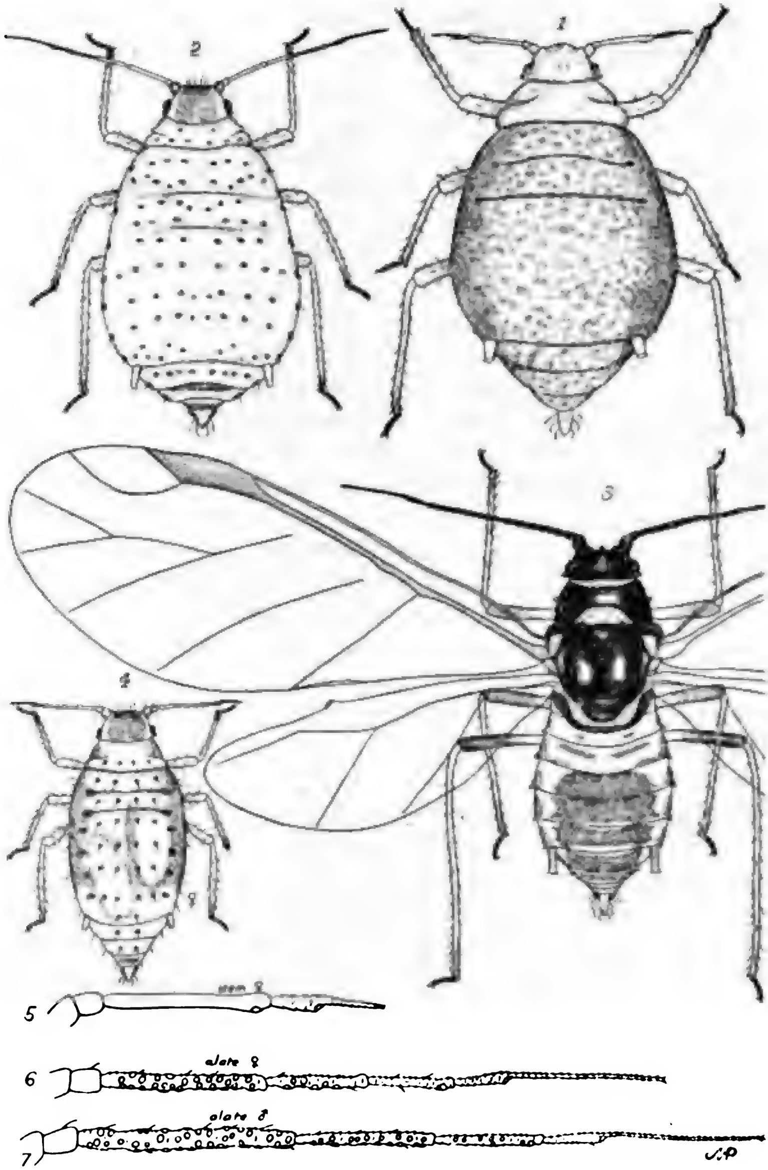
The general color is light yellowish brown; head, thorax, cornicles, antennæ, distal end of beak, coxæ, tarsi, distal ends of femora and tibiæ, eyes, mesothorax below and a large spot on either side of the mesopleurum black; style, anal plates, a row of spots on the lateral margins of abdomen, about six transverse dashes on the abdominal segments above, dusky brown to black; length of body about 1.70 mm.; length of wing 2.20 mm.; length of antennæ 1.40 mm.; joints of antennæ as follows: I and II, .11 mm.; III, .41 mm.; IV, .26 mm.; V, .21 mm.; VI, .12 mm and VII, .29 mm; style .10 mm.; cornicles .07 mm. The cornicles are cylindrical in form and are about twice as long as broad; joints three, four and five of the antennæ strongly tuberculate, with numerous circular sensoria; on joint III about 30 to 40; IV, 15 to 18; V, 8 to 10; Plate 9, fig. 7.

EXPLANATION OF PLATE

PLATE 9.—*Aphis bakeri*; 1, stem-mother; 2, apterous viviparous female; 3, alate female; 4, oviparous female; 5, the 5-jointed antenna of the stem-mother; 6, antenna of alate viviparous female; 7, antenna of male. Figures 1, 2, 3 and 4 are enlarged 30 diameters; figures 5, 6 and 7, 80 diameters; M. A. Palmer, artist.

Figures 3 and 5 were used in Bulletin 133 of the Colo. Exp. Sta.

ERRATA: On plate 6, figure 4, for alate read *apterous*.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J.P

DIMPLES IN APPLES FROM OVIPOSITION OF LYGUS PRATENSIS L.

By Estes P. Taylor, *Mountain Grove, Missouri*

To one conducting experiments against insect pests infesting fruits it is especially important that the cause of all external blemishes upon the fruits be known. Failure to recognize the cause of such injuries has often been responsible for misleading and incorrect conclusions regarding the effectiveness of insecticidal sprays. Mistaken identification of insect work is often brought about by superficial examination of fruit at picking. At this time the growth of the fruit has often so completely altered the appearance of the injury that its true cause is never suspected.

Careful and almost continuous observations in an apple orchard this season from the time of the formation of the fruit to harvest resulted in the discovery that an injury of doubtful nature but resembling and formerly classed as that caused by the plum or the apple curculio was, instead, the result of egg punctures made in the very early development of the apple by the common tarnished plant-bug (*Lygus pratensis* L.). On account of their direct bearing upon the examinations of apples by those conducting spraying experiments in the control of curculio upon apple, the results of these observations are herein reported. The observations also add new information upon the egg-laying habits of the tarnished plant-bug, one of the oldest recorded insects in North America.

Late in March at Mountain Grove, Missouri, my attention was called to the great abundance of the tarnished plant-bugs about the buds and newly opened blossoms of early blooming varieties of peach. They were noted in great numbers about the blossoms of peaches in the station orchard by the director of the station, while engaged in hand pollinating blossoms. Many blossoms were seen at this time which had evidently been blasted by this insect having pierced the tissue and sucked away the juices of the essential organs of the bloom. A very noticeable percentage of the blossoms were noted at that time darkened and shrunken and falling away, evidently from this cause. At Olden, on March 27, I noticed numbers of the bugs about the buds of peach, plum, apple and pears, and in making jarrings for curculio under peach and plum trees a number of the bugs were collected upon the jarring sheet. On April 10, while examining with an assistant, Mr. C. B. Dull, fruit buds in an apple orchard selected for a spraying experiment with curculio and codling-moth, small dark-colored spots were noticed upon the sides of the ovary of the apple bloom. These

spots were first noticed upon apples of the Blue Pearmain variety, which had only within the past two or three days completed the shedding of the petals, and upon none of which were the calyces closed. At first the spots were taken as the first evidences of apple scab. A closer inspection suggested the feeding punctures of the plum curculio. Examining the spots under a hand lens I discovered to my surprise that in the center of the discolored area there was a distinct opening in the skin of the apple and that within this opening and just beneath the surface was an oval, elongate, bottle-shaped egg. At first I did not recognize the egg as any with which I was familiar. The abundance of the tarnished plant bug upon the blossoms of the different orchard trees mentioned suggested their association with the eggs found, which was substantiated a moment later by the capture on these trees of gravid female specimens of *Lygus pratensis*, from which eggs were dissected. These eggs corresponded perfectly with the ones found deposited within the minute apples. By dissection two females yielded fourteen well defined eggs each. To further substantiate the observation a large number of the newly formed apples, containing what appeared to be freshly deposited eggs, were confined in a breeding cage in the insectary. Hatching began eight days later, yielding the young of this plant-bug. These were kept alive in the cage until they had entered the second or third instar, in which they demonstrated plainly the characteristic markings upon thorax and body, distinguishing this species from related ones. Besides the apples cut open in examination for eggs and those reserved for breeding cages, a considerable number of small apples were picked at random from two or three Blue Pearmain trees on April 10 and examined in the laboratory with the following results:

Number of apples examined	110
Number eggs found	65
Number feeding punctures	11
Apples bearing eggs	45

In this case it will be seen that about 40 per cent of the apples bore egg punctures of this insect. The average number of eggs per apple in infested apples was 1.44. One small apple was found containing four punctures with eggs, four contained three eggs each and nine apples bore two eggs apiece. The eggs measured upon an average .782 mm. in length by .241 mm. in diameter at their widest point. They were smooth and slightly curved, with the end deepest in the tissue bluntly rounded. The end of the egg nearest the surface was truncate and slightly compressed and bore around the margin a white tubular fringe, finely striated. The color was very pale yellow.

The eggs were found laid singly in the fruit, though where very small apples contained several the distance between them was often very small. Sometimes two or three would be found arranged in a row, not more than one millimeter apart, but each egg occupying a separate and distinct incision. The usual rule was that of single and scattering egg punctures. The eggs were placed on end or at right angles with the surface of the apples, snugly fitting into the incisions made for them. These incisions when made in the sides of the ovaries of blossoms which had but recently shed their petals were of depth sufficient to pierce the carpel walls. In one instance an egg was found in an incision made within the stem of the miniature apple. Out of thirty-six egg incisions counted, fifteen were in the third nearest the tip or calyx end, thirteen were in the middle third, and eight were made in the third nearest the stem. The eggs are deposited in the apple usually with the outer end just beneath the surface of the skin. Quite often the growth of the tissue of the apple forces the eggs outward lengthwise and they may often be seen with their whitish truncate tube-like ends extruded into view as much as one third or one half the length of the eggs. It is not altogether unlikely that this may be in some cases due to shallow egg laying by the female. When not extruded in this manner they are difficult to discern, as the heavy pubescence over the minute apples conceals them. Freshly laid eggs are more difficult to discern since the tissue surrounding has not become discolored.

Eggs are laid sometimes before the petals fall from the blossom and probably some are deposited while still in the bud. No freshly laid eggs were found in any case after the apples were more than one third of an inch in diameter, and usually not later than the time of the closing of the calyx. The past spring the early blooming varieties suffered more heavily than those opening later. Though eggs were hatching from Blue Pearmain on April 18 the eggs laid in late blooming Ingram were found hatching in the orchard May 1. The adults became more scarce upon fruit trees after the dropping of the petals, although some were seen resting upon the fruit of peaches, when they measured over an inch in diameter. Although the insect is reported as one with two or three generations in Missouri, no egg laying was observed in the apples at any time through the summer.

To determine the effect of the egg-laying upon the development of the fruit a close watch was kept of marked apples known to have had the egg puncture of this insect made upon them. It seemed apparent that the injury probably caused the dropping of some of the small apples soon after setting. By far the larger percentage of affected

apples, however, had their growth arrested at the point of egg laying, which with the growing of surrounding tissue brought about the formation of small, funnel-shaped pits upon the surface about each egg incision. Upon the 14th of May, while the Ingram apples were still small and covered with a fuzzy pubescence, 31 fruits which bore 36 unmistakable egg pits from the tarnished plant-bug were carefully marked upon the trees. These were observed from time to time and development of the egg-pits noted up to the time of the full maturity of the fruit, which was harvested October 6. Although, as stated, the variety did not seem so heavily infested as some of the earlier blooming ones, a count of 2,189 apples picked from nine small trees showed about 3 per cent with well defined cavities upon their surface due to this cause. Some apples bore as many as five egg-pits each. Measurements of twenty-one cavities upon apples varying from two to three inches in diameter gave an average distance across the top of the depression of .49 inch, with a variation of from .30 to .75 inch. From the surface the sides of the cavity sloped gradually to the bottom, forming an inverted cone-shaped depression with an average depth of .17 inch and a variation of from .08 to .35 inch. Leading inward into the apple from the bottom of the cavity is a greenish, pithy tissue, which extends in a straight line toward the core, sometimes terminating within and sometimes just outside the carpel walls. If the injury has been near the stem or calyx end of the apple the threadlike canal may reach the core above or below the poles of the carpels. This hardened tissue is sometimes of a tubular form, having an average diameter of about .02 inch. It is sometimes open but is for the most part filled with a loose, brown, cellular tissue. It is the outgrowth of the original cavity in which the eggs were laid and in one instance what appeared to be an empty egg-shell was dissected from the base of one of these egg-pits in a matured apple on October 31, fully six months from the date of oviposition, the observation affording still further and convincing proof of the cause of the injuries noted. The egg-pits must be considered of some economic importance to the fruit grower but they do not seriously affect the keeping quality of the fruit and, except in cases which cause serious distortion of the fruit, does not lower its grade.

That injuries in apples due to the oviposition of the tarnished plant-bug may be expected in any portion of the United States where this fruit is grown is probable, since this insect is widely distributed. Such an omnivorous feeder may be expected to be present and ready for oviposition in apples in the spring in almost any quarter. The typical egg-pits of this insect were noted the past season, more or less,

in all fruit districts visited in Missouri. It is known to occur over the United States, from the sea-coast to above timber-line on the highest mountains of the Rockies in Colorado. It ranges south into Mexico and north far into Canada. It is one of the well known insects of Europe, having first been described by Linnaeus in 1767 and again under another name by Palisot de Beauvois in France from insects collected in Africa and America. It was first brought to the notice of American entomologists by Thomas Say in 1831 and mentioned as an injurious insect by Harris in 1841. It is mentioned as an economic pest by Riley, Walsh, LeBaron, Cooke, Glover, Saunders and Lugger and has at some time or other been included in the reports of nearly every leading entomologist in the country.

So far as the writer is aware this record is the first of oviposition of the insect in apples, or in fact in any fruit. Professor Woodworth states that the egg of this insect was not known at all until 1884 when Doctor Forbes, after a protracted search, succeeded in finding a single specimen among the hairs of the petiole of a dead strawberry leaf, and Professor Slingerland is reported to have found their eggs in blighted peach twigs in New York.

It was no small satisfaction to the writer to be able to accurately identify these egg-pits this fall upon apples in experimental blocks, very successfully treated for the control of curculio and codling-moth. Without this knowledge I should have been led to classify the injuries as the very early food punctures of the apple curculio (*Anthonomus quadrigibbus* Say), or even the early food punctures of the plum curculio (*Conotrachelus nenuphar* Hbst.). It seems possible that failures, or at least only partial successful results, which have been reported in the control of curculio upon apples with arsenical sprays, has been due to this mistaken identity of injuries.

Remedies or preventive measures will not be discussed in this article, but it has been observed by the writer that orchards where clean cultivation is practised and where a minimum number of adults are permitted to hibernate through the winter suffer least from spring oviposition in the fruit.

The photographs reproduced herewith show the egg-pits from the tarnished plant-bug in Ingram apples in their various stages of growth. Fig 1, Plate 10, in which the size of the apples is reduced about one half, shows the depressions upon apples when very small, still coated with pubescence and less than a month after the hatching of the plant-bug eggs. Fig. 2, Plate 10, shows apples of about one third size, about two months from egg hatching. These well illustrate the depressions which may be appropriately spoken of as "dim-

Plate 10

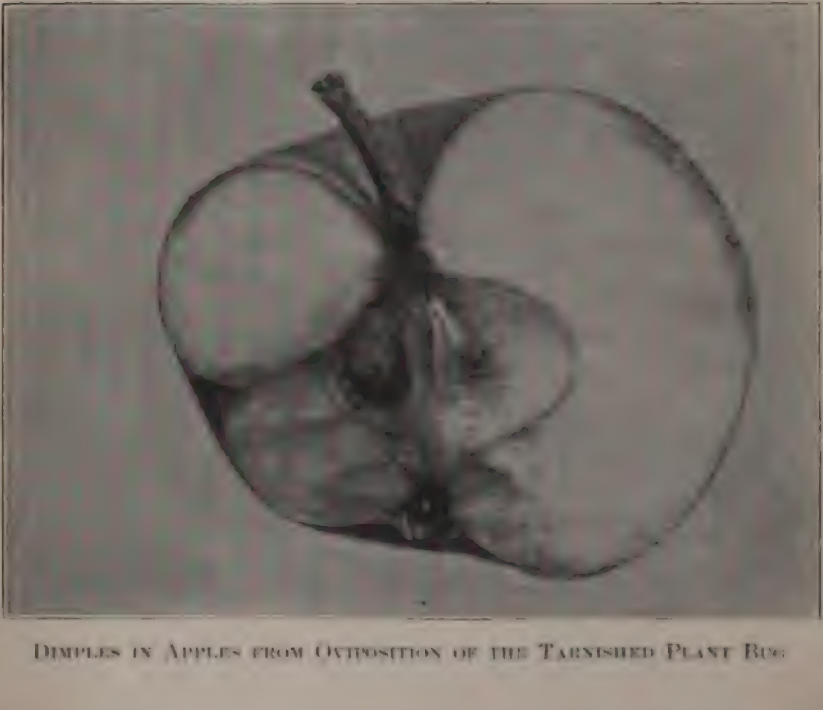
1

2

DIMPLES IN APPLES FROM OVIPOSITION OF THE TARNISHED PLANT BUG

Plate 11

1



2

DIMPLES IN APPLES FROM OVIPOSITION OF THE TARNISHED PLANT BUG

ples." Fig. 1, Plate 11, was taken about two months from the hatching of the plant-bug egg and shows apples and dimples about natural size. One of the apples exhibits two dimples on the surface shown. In Fig. 2, Plate 11, is shown an Ingram apple about natural size in longitudinal section, with the depression and pithy tube, the outgrowth of the egg incision, extending nearly to the core. The axis of the apple is twisted, resembling distortions from other insect injuries. This photograph was taken at harvest time, about five months from the hatching of the egg of the tarnished plant-bug.

NOTES ON THE GRASS MITE, PEDICULOPSIS GRAMINUM REUTER

H. E. Hodgkiss, *Geneva, N. Y.*

This species belongs to the Tarsonemidæ, which is a small family of the order Acarina. The mite was first described in 1900 by Dr. Enzio Reuter,[1] from specimens taken from grass in Finland, and was placed by him in the genus *Pediculoides* under the specific name *graminum*. Doctor Reuter afterwards recognized characters of generic significance in this species and thereupon erected the genus *Pediculopsis*, naming *graminum* as the type.[2]

The importance of the species was first indicated by Doctor Reuter in a publication entitled "*Über die Weissährigkeit der Wiesengräser in Finland.*"[1] In Bank's list of the Acarina of the United States[3] no mention is made of this mite, and its identity in this country appears not to have been determined until the present time.

In 1905 Dr. R. H. Wolcott mentioned the appearance of a mite in carnation buds.[4] During the following year the presence of a mite was noted in carnation buds grown on Long Island, and in 1907 it was identified as *Pediculoides graminum* Reuter. In 1908 Heald and Wolcott published an account of the species under the name *Pediculoides dianthophilus*.[5]

Carnation buds infested with the mite were received from Professor Heald, for the purpose of identifying the Nebraska species, which proved to be the same as the one found in New York. That there might be no doubt as to its identity, specimens were sent to Doctor

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[1]Acta Societatis pro Fauna et Flora Fennica, 19: N:o 1. 1900.

[2]Festschrift für Palmén, N:o 7, p. 3, footnote 2. Helsingfors. 1907.

[3]Proc. U. S. Nat. Mus., 32: 615.

[4]Science, N. S., 21:389. 1905.

[5]Neb. Sta. Bul. 103. 1908.

Reuter for determination and were pronounced by him to be identical with the species he had described as existing on grasses in Finland. It therefore appears that *P. dianthophilus* Wolcott is a synonym of *P. graminum* Reuter.

Pediculopsis graminum Reuter appears to be a widely distributed species in the United States. It has been taken from carnation buds in Nebraska[1] and in widely separated sections of Illinois.[2] In New York state it is a rather common species upon several grasses, from which it is probably distributed to carnation plants growing in the field and subsequently is introduced into greenhouses.

The work of the mite on grass and on carnations is quite dissimilar. On grass it attacks the succulent stem within the sheath, just above the topmost node. The growth of the stem at this point is checked, causing the partially opened panicles to ripen prematurely and giving rise to the condition known as silver top. The portion of the stem which is attacked gradually shrivels and becomes twisted at or just above the node. During the early spring a decay of the injured portion of the stem is usually found. It always appears when the area attacked is close to the ground, where the presence of moisture is favorable for its growth. This decay is due to a fungus which Prof. F. C. Stewart has determined to be *Sporotrichum poæ* Peck.

On carnation plants the mite does not attack the stem but works into the center of the young buds. Here it introduces the same fungus with which it is associated on grass. Experiments made for the purpose of determining the point of attack indicate that the stamens and pistils are first attacked and later the less tender tissues. The fungus then finds a favorable condition for growth and in a comparatively short time the heart is entirely decayed and filled with mites, while the growth of the buds is checked.

The relation of the mite to the fungus is not entirely clear. It appears, however, that the mite visits healthy carnation buds for the purpose of feeding on the tender tissues of the floral organs. Spores of the fungus are thus introduced into the interior portions of the bud, which eventually cause it to decay. The mites breed in this decaying tissue and the subsequent generations migrate to healthy buds, infecting them with the spores of the fungus.

Probably the mite and its accompanying fungus will rarely be sufficiently destructive to require special methods for their control. To prevent unusual infestations it may be desirable to gather the infested buds and burn them. The elimination of susceptible varieties,

[1]Neb. Sta Bul 103 1908. [2]J. J. Davis, Urbana, Ill.

such as Lawson, Enchantress and Bradt may also prove to be advantageous.

The temperature necessary for successful carnation culture is quite favorable for the development of insects and diseases common to carnation plants. For this reason the future of *Pediculopsis graminum* and the associated fungus, *Sporotrichum poæ*, as parasites of the carnation, will be watched with considerable interest.

EXPERIMENTS FOR THE CONTROL OF THE RED SPIDER IN FLORIDA (TETRANYCHUS BIMACULATUS, HARV.)

By H. M. Russell, *Bureau of Entomology, Washington, D. C.*

During the early spring of 1908, it was very dry for weeks in Florida, with little rainfall. Under these conditions red spider injury to truck, general crops, and citrus trees was very noticeable. The writer found a small field of wax beans very badly infested by the red spider, May 16, 1908. Some of the leaves were badly distorted and curled, and discolored by numerous yellow blotches, while others were dried up and lifeless from the work of this insect. The red spider lives on the under side of the leaves, spinning a slight web of delicate threads, under the protection of which it feeds.

About the first of June the rainy season in Florida set in and when the plants were examined about a week later, the red spider had almost disappeared.

Experiments for the control of the red spider were conducted at Orlando, Fla., from May 22, until June 1, 1908, the results of which are summarized below.

Experiment No. 1.—May 22, 1908. Lime-sulphur (at the rate of 1 pound of lime and 1 pound of sulphur to 25 gallons of water,[1] *a*) was sprayed on a row of wax beans, using an underspray. This was at 5.30 p. m., the sky being cloudy, and a fair breeze blowing. On May 28, a number of leaves of sprayed plants were examined as were leaves of unsprayed plants also (for the purpose of checking), with the following results:

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[1]In Circ. 65, U. S. Dept. of Agriculture, Bur. Ent., Prof. E. S. G. Titus states that the heat generated by slaking lime will dissolve the sulphur. The writer finds that, when made up in small lots, it is necessary to boil the two ingredients together as enough heat is not generated to dissolve the sulphur.

TABLE FOR FORMULA *a*

No. of leaf	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Live red spiders on leaves sprayed	3	7	1	100	7	1	1	1	0	10	8	7	2	2	16	1
Live red spiders on unsprayed leaf	80	78	39	36	37	36	12	55	2	59	60	26	0	3	5	5

Total number red spiders left on plants sprayed, 167 (1).
Total number red spiders left on plants unsprayed, 533.

The above figures show a total of 76 per cent killed by the one spraying; the plants showing no injury from the spray.

Experiment No. 2.—May 28, 1908. Lye-sulphur (1 pound sulphur and ½ pound of lye to 40 gallons of water, *c*) was sprayed on a row of wax beans, using an underspray. The spray was applied at 10.15 a. m., the day being cloudy and there being a fair breeze. On May 30, 1908, an examination was made of a number of sprayed leaves and checks, the results of which are as follows:

TABLE FOR FORMULA *c*

No. of leaf	1	2	3	4	5	6	7	8	9	10	11	12	Total
Live red spiders on leaves sprayed	0	1	1	0	0	0	0	0	3	0	0	0	5
Live red spiders on unsprayed leaf	1	77	74	6	17	39	3	8	37	11	1	1	275

This count gives 98.4 per cent killed by the one spraying, and seems a very high percentage to the writer. The plants show no injury resulting from the spraying.

Experiment No. 3.—May 28, 1908. Sulphur (1 ounce to 1 gallon of water, *d*) was sprayed on a row of wax beans, using the underspray. The spraying was done at 11 a. m., the sun shining brightly and there being a fair breeze. On May 30, a number of sprayed leaves and checks were examined with the following results:

TABLE FOR FORMULA *d*

No. of leaf	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Live red spiders on leaves sprayed	0	1	1	0	1	0	1	1	4	?	0	0	0	0	1=10
Live red spiders on unsprayed leaf	5	3	3	1	4	17	2	8	10	?	4	22	11	10	5=110

[1] Of the sprayed leaves, one examined had 100 red spiders upon it and, it seems to the writer, that a truer result would be obtained by ignoring this one leaf and its check.

This count gives 91.7 per cent killed by this spraying. Plants show no signs of damage from spraying. On the date of this examination the sulphur was found still adhering to the beans in small particles.

(*c*) In making this spray the lye should be finely pulverized.

(*d*) In making this spray the sulphur should be made into a thin paste with a small amount of water, after which the balance of the water is added.

Experiment No. 4.—May 29, 1908. Kerosene-soap emulsion (1 part of the stock solution to 10 parts of water, *e*) was sprayed on a row of wax beans, using an underspray.

This was applied at 10.30 a. m. with a bright sun and a good breeze. On May 30 a number of sprayed plants and checks were examined with the following results:

TABLE FOR FORMULA *e*

No. of leaf	1	2	3	4	5	6	7	8	9	10	11	12	Total
Live red spiders on leaves sprayed	1	0	0	0	2	0	0	1	1	0	0	0	5
Live red spiders on unsprayed leaf	5	3	3	1	4	17	28	10	5	4	22	11	118

This count gives a total of 95 per cent killed by this spray. The plants show a few leaves with burned edges, but in no case seriously.

(*e*) This stock was made up four weeks previous to using, and the writer finds a small amount of free oil.

SUMMARY OF EXPERIMENTS IN SPRAYING FOR THE RED SPIDER

No. of Expt.	Date.	Insecticide.	Effect on Red Spider.	Effect on Plant.
1	May 28	Lime-sulphur	Killed 68 to 85%	None.
2	May 28	Lye-sulphur	Killed 98%	None.
3	May 28	Sulphur-water	Killed 91%	None.
4	May 29	Kerosene emulsion	Killed 95%	Slight.

Conclusion

The results of these experiments show that this pest can be controlled by spraying with any of these four insecticides; but because of the difficulty experienced in making the kerosene emulsion, as compared with the other three, it is not likely to be employed, at least in Florida.

At the same time that these experiments were conducted, observations were made on the effect of rain on the red spider. On the 27th

and the 30th of May it rained very hard, and on June 2d a check row of beans was examined and 207 red spiders were found on 13 leaves.

On June 8th, after a week of daily rain, very few red spiders were to be seen. From this it appears that one or two rains will not seriously injure the red spider, but that continued rains for several days are fatal to a large proportion of the insects.

A LIST OF PARASITES KNOWN TO ATTACK AMERICAN RHYNCHOPHORA

By W. Dwight Pierce, *Bureau of Entomology, U. S. Dept. of Agriculture*

As the weevils become more important economically there will be a growing necessity of understanding the parasites which may check their injuries. A preliminary list of these parasites was published by the writer in Bulletin 73 of the Bureau of Entomology, without, however, indicating the sources of the records. Since that time many other important records have been added, and if all the species bred by the boll weevil investigation force were determined, double the number of additions could be included.

The credit for parasite breeding records made at the boll weevil laboratory during 1907 and 1908 must be shared equally by the writer with Messrs. R. A. Cushman and C. E. Hood.

Notice of omissions is very earnestly requested.

Fungi.

Aspergillus sp. is recorded by Hunter and Hinds (1904. 105) as bred from *Anthonomus grandis* Boh., at Victoria, Texas.

Cordyceps sp. was found attacking the boll weevil (*Anthonomus grandis*) at San Juan Allende, Mexico (Townsend 1895a).

Empusa (*Entomophthora*) *sphaerosperma* attacks the clover-leaf weevil, *Phytonomus punctatus* Fab., abundantly at Annapolis Junction, Md. (Johnson 1898).

Entomophthora phytonomi attacks the same weevil in Ontario (Fletcher 1900).

Isaria tomicii Lugger is recorded as killing adult *Platypus compositus* Say (Hopkins 1896).

Sporotrichum globuliferum was bred from the imbricated snout beetle, *Epicaerus imbricatus* Say, by (Chittenden (1900b. 31).

Acarina.

Tarsonemidae.

Pediculoides sp. (nec *ventricosus* Newp. mis-spelled *ventriculosus*) is a common parasite of *Anthonomus grandis* Boh. (Rangel 1901a, b) and

Anthonomus eugenii Cano, the pepper weevil, (Meraz 1905), in Mexico, and is used by the boll weevil investigation in Texas.

Pediculoides sp. nov. is a parasite first discovered in the Dallas laboratory attacking *Trichobaris compacta* Casey and *Anthonomus grandis* Boh. It was later found to attack any insect within its reach.

Pediculoides sp. is recorded from *Laria* (*Bruchus*) *chinensis* Linn. by Chittenden (1899. 245) under the name of *Pediculoides ventricosus* Newm. (The genus *Bruchus* Linn. 1767 is a synonym of *Laria* Scop. 1763 according to Ganglbauer (1903. 308).

Tyroglyphidae.

Tyroglyphus breviceps Banks (1906) was described as a parasite of *Anthonomus grandis*.

Diptera. Cyclorrhapha.

Phoridae.

Aphiochaeta nigriceps Loew. (det. by Coquillett) was bred September 26, 1906, from "a very small parasite larva on small weevil larva" isolated from dry hanging bolls collected September 12th at Dallas, Texas. The puparium, larval skin and remains of the weevil larva in the breeding tube were the proofs of primary parasitism.

Aphiochaeta fasciata Fallen (?) (det. by Coquillett)
Aphiochaeta pygmaea Zett. (det. by Coquillett) On October 6, 1906, a weevil larva was isolated from hanging bolls collected at Dallas, Texas, with this note: "Weevil larva full of Dipterous larvae." Eleven larvae left this host and pupated. On October 29, seven of the first species and two of the latter were bred.

Tachinidae.

Metadexia basalis G. T. (det. by Coquillett) is contained in the U. S. National Museum as a parasite of *Conotrachelus juglandis* Lec. from West Virginia.

Cholomyia inaequipes Bigot (det. by Townsend) is contained in the U. S. National Museum as a probable parasite of *Conotrachelus nenuphar* Hbst. in Missouri, and as bred from *Conotrachelus juglandis* Lec., taken at Mounds, Louisiana, August 30, 1897 (U. S. D. A. 7662[01]). This species was bred May 29, 1907, from *Conotrachelus elegans* Boh. at Dallas, Texas.

Myiophasia aenea Wied. (det. by Coquillett) is a parasite of *Balaninus nasicus* Say, *Conotrachelus juglandis* Lec., *Sphenophorus parvulus* Gyll. (Coquillett 1897); *Ampeloglypter sesostris* Lec. (Webster); *Anthonomus grandis* Boh. (Pierce 1907b. 269, 1908a. 40); *Conotrachelus affinis* Boh. (Pierce 1907b. 274). It is a common parasite of *Conotrachelus elegans* Boh. The Sphenophorus record is based on *Phasioclista metallica* Towns., supposed to be a synonym of *M. aenea* Wied.

Myiophasia robusta Coq. is a parasite of *Sphenophorus robustus* Horn (Coquillett 1897).

Myiophasia setigera Towns. type, was collected ovipositing in an acorn of *Quercus alba* at Ruston, La., October 31, 1907, by the writer.

Ennyomma clistoides Towns. (according to Mr. Townsend this species is distinct from *Myiophasia aenea* Wied.) is a parasite of *Chalcodermus aeneus* Boh. (Howard 1894. 280; Chittenden 1904. 43).

Ennyomma [Loewia] globosa Towns. (according to Mr. Townsend this species also is distinct from *Myiophasia aenea* Wied.) was bred from the boll weevil, *Anthonomus grandis* by C. R. Jones throughout the fall of 1907 at Alexandria, La.

Lixophaga parva Towns. type, was bred August 15, 1907, at Dallas, Texas, from *Lixus scrobicollis* Boh. The weevil skin was attached to the outside of the puparium.

Hymenoptera. Vespoidea.

Bethylidae. Bethylini.

Cephalonomia hyalinipennis Ashm. is recorded as possibly a parasite of *Hypothenemus eruditus* Westw. (Chittenden 1893b. 250; Ashmead 1893a. 49, 451). This record is open to doubt.

Hymenoptera. Proctotrypoidea.

Platygasteridae. Platygasterinae.

Trichacis rufipes Ashm. is possibly a parasite of *Balaninus nasicus* Say (Ashmead 1893a. 296, 451)., This record is open to doubt.

Hymenoptera. Chalcidoidea.

Torymidae. Monodontomerinae.

Microdontomerus anthonomi Cwfd. attacks *Anthonomus grandis* Boh. and *Anthribus [Brachytarsus] alternatus* Say (Crawford 1907a. 133; 1907b. 179), being very abundant in central Texas on the boll weevil. (Brachytarsus Sch. 1833 = Anthribus Forst. 1771 according to Ganglbauer 1903. 311). This parasite was also bred in both sexes at Dallas, Texas, from *Laria [Bruchus] exigua* Horn.

Chalcididae. Chalcidinae. Smicrini.

Spilochalcis sp. A single male of this species was found dead in a weevil cell with the remains of the weevil and its own exuvium in a hanging square collected August 10, 1907, at Victoria, Texas.

Eurytomidae. Eurytomini.

Eurytoma magdalidis Ashm. was described as parasitic on *Magdalis armicollis* Say (Ashmead, 1896a. 326).

Eurytoma tylodermatis Ashm. was described as parasitic on *Tyloderma foveolatum* Say (Ashmead 1896a. 218). It is parasitic on *Lixus musculus* Say, and *Anthonomus squamosus* Lec. (Pierce 1907a; b; c; 1908a), on *Orthoris crotchii* Lec (Pierce 1907b; 1908a); on *Anthonomus heterothecae* Pierce (nec. *disjunctus* Lec.) (Pierce 1907a; b; 1908a, d), on *Anthonomus grandis* Boh. (Hunter and Hinds 1904; 1905, Pierce 1907b, 1908a, c), on *Apion segnipes* Say (Chittenden 1908. 31). It was bred abundantly from the typical Laria in *Vachellia farnesiana* taken at Victoria, Texas, from *Spermophagus robiniae* Sch. collected at Shreveport, La., from *Lixus scrobicollis* at Dallas, Texas; and from *Trichobaris texana* Lec at Cisco and Dallas, Texas; and was

also bred from typical *Macrorhoptus sphaeralciae* Pierce collected at Del Rio, Texas. *Bruchophagus herrerae* Ashm. described from *Anthonomus grandis* is a synonym of this species, according to J. C. Crawford.

Bruchophagus mexicanus Ashm. was bred in Arizona from *Laria* [*Bruchus*] *alboscutellatus* Horn and *L.* sp. (Townsend 1895b).

Perilampidae.

Perilampus sp. A single individual was bred from the boll weevil, *Anthonomus grandis*, in an isolated weevil cell, by C. E. Hood, from squares collected September 7, 1907, at Shreveport, La.

Cleonymidae. Cleonyminae.

Cheiropachys colon Linn. attacks *Magdalis aenescens* Lec. (Chittenden 1900a. 37, 43) and *Eccoptogaster* [*Scolytus*] *rugulosus* Ratz (Howard 1888).

Encyrtidae. Eupelminae. Eupelmini.

Cerambycobius brevicauda Cwfd. was described as a parasite of *Laria exigua* Horn, bred at Dallas, Texas (Crawford 1908. 158).

Cerambycobius bruchivorus Cwfd. was described as a parasite of the typical Laria in *Vachellia farnesiana* from Victoria, Texas, bred at Dallas, (Crawford 1908. 158).

Cerambycobius cushmani Cwfd. was described as a parasite of *Anthonomus grandis* from Victoria, Texas (Crawford 1908. 158) at which place it has deflected in large numbers from its original host, the typical Laria in *Vachellia farnesiana*, due to the failure of that plant to fruit. It was also bred as parasite of the boll weevil at Hallettsville, Goliad, and Brownsville, Texas, and Alexandria, La., and from *Araecerus fasciculatus* Woll. at Victoria, Texas.

Cerambycobius cyaniceps Ashm. is a very common parasite of *Anthonomus grandis* throughout Texas and Louisiana (Mally 1902; Pierce 1907b; 1908a, c). It is also a parasite of *Tyloderma foveolatum* Say (Pierce 1908a), *Laria exigua* Horn (Chittenden 1893b), *Lixus musculus* Say, *Anthonomus albopilosus* Dietz (Pierce 1907b, c; 1908a), *Trichobaris texana* Lec. (Pierce 1907b; 1908a), *Laria obtecta* Say (Chittenden 1899. 242). It was an abundant parasite of *Laria exigua* Horn collected at Dallas; was bred from the huisache (Vachellia) Laria collected at Victoria; from *Spermophagus robiniae* Sch. and *Lixus scrobicollis* Boh. at Alexandria, La.; from fruit of *Crataegus mollis* at Victoria, Texas, infested by *Tachypterellus quadrigibbus* Say and *Conotrachelus crataegi* Walsh; from *Trichobaris compacta* Casey collected at Paris, Texas; from Baptisia pods infested by *Tychius sordidus* Lec.; and was also bred at Washington by J. A. Hyslop from *Apion rostrum* Say.

Tanaostigmodes tychii Ashm. was described from *Tychius semisquamosus* Lec. (Ashmead 1896. 20).

Encyrtidae. Eupelminae. Tanaostigmini.

Eutrichosoma albipes Cwfd. was described from *Auleutes tenuipes* Lec. upon which it breeds abundantly at Dallas, and from *Smicronyx tychoides* Lec. upon which it is very abundant at Victoria (Crawford 1908. 158).

Pteromalidae. Pteromalinae. Metaponini.

Bruchobius laticollis Ashm. attacks *Laria obtecta* Say (Chittenden 1899. 242) and *Laria pisorum* L. (Pierce 1908. 42).

Pteromalidae. Pteromalinae. Rhaphitelini.

Rhaphiteles [*Storthygoccrus*] sp. was bred from *Magdalis armicollis* Say (Hubbard 1874).

Rhaphiteles maculatus Walk. is recorded from *Eccoptogaster* [*Scolytus*] *rugulosus* Ratz (Howard 1888).

Dinotus sp. attacks *Magdalis aenescens* Lec. (Chittenden 1900a. 42).

Habrocytus rhodobaeni Ashm. was described from *Rhodobaenus tredecimpunctatus* Ill. (Ashmead 1896a. 220; Howard 1900. 105).

Pteromalidae. Pteromalinae. Pteromalini.

Meraporus calandrae How. attacks *Calandra oryzae* Linn. as well as *Sitodrepa panicea* Linn. (Howard, Comstock 1881. 273; Chittenden 1897. 43–45).

Meraporus bruchivorus Ashm. was described as a parasite of *Laria exigua* (Ashmead 1893. 161).

Meraporus n. sp. has been bred from *Calandra oryzae* by E. S. Tucker at Plano, Texas.

Catolaccus anthonomi Ashm. was described from *Anthonomus signatus* Say (Chittenden 1893a. 185) and also bred from *Anthonomus nigrinus* Boh. (Chittenden 1895. 351). A species closely resembling this attacks *Anthonomus grandis* in the fall at Waco and Dallas, Texas.

Catolaccus coeliodis Ashm. was described from *Acanthoscelis* [*Coeliodes*] *acephalus* Say (Ashmead 1896. 227).

Catolaccus hunteri Cwfd. was described from *Anthonomus grandis* Boh. at Mineola and Waco, Texas (Crawford 1908. 160), and has also been bred in many other parts of southwestern Texas. It is a parasite of *Anthonomus albopilosus* Dietz in south Texas, *A. eugenii* Cano, the pepper weevil, *A. squamosus* Lec. at Clarendon, Texas, *A. signatus* Say from dewberries in south Texas, *A. aeneolus* Dietz throughout central and west Texas, *A. heterothecae* Pierce at Jacksonville, Texas, *Tachypterellus quadrigibbus* Say at Victoria, Texas, and *Zygobaris xanthoxyli* Pierce at Runge and Beeville, Texas. It was formerly confused with the following species.

Catolaccus incertus Ashm. was described from *Anthonomus signatus* Say (Chittenden 1893a. 1896). Since this species has in the past been confused with the preceding species only the following records may be credited to it: *Anthonomus nigrinus* Boh. (Chittenden 1895. 351), *Apion decoloratum* Sm., *Apion griseum* Sm. (Chittenden 1908. 30, 32), *Laria exigua* Lec. (Pierce 1908. 37). It also attacks *Anthonomus grandis* Boh. mainly in east Texas and Louisiana, *A. albopilosus* Dietz in Louisiana, *A. aphanostephi* Pierce, *A. fulvus* Lec. and *Auletes tenuipes* Lec. in Texas.

Neocatolaccus tylodermae Ashm. was described from *Tyloderma foveolatum* Say (Ashmead 1893. 161), and is also recorded from *Ampeloglypter sesostris* Lec. (Webster 1900), *Lixus musculus* Say (Pierce 1907,

1908), *Lixus mucidus* Lec. (Pierce 1907, 260) and *Lixus parcus* Lec. (Pierce 1908. 43).

Pteromalidae. Spalangiinae.

Cerocephala elegans Westw. is a parasite of *Calandra oryzae* Linn. and also of *Sitodrepa panicea* Linn. (Chittenden, 1897. 44).

Cerocephala pityophthori Ashm. attacks *Pityophthorus consimilis* Lec. (Riley and Howard 1891. IV. 123).

Cerocephala scolytivora Ashm. is parasitic on *Loganius ficus* Schwarz (Riley and Howard 1891. IV. 122).

Eulophidae. Entedoninae. Omphalini.

Omphale elongatus Ashm. was bred from *Attelabus rhois* Boh. at Wales, Maine, by C. E. Frost (Psyche 1904).

Omphale livida Ashm. is a parasite of *Ceutorhynchus rapae* Gyll. (Chittenden 1900b. 49).

Eulophidae. Entedoninae. Entedonini.

Horismenus [*Holcopelte*] *popenoi* Ashm. is probably hyperparasitic on *Spermophagus robiniae* through *Coenophanes spermophagi* Ashm. (Wickham 1895).

Horismenus lixivorus Cwfd. is described as parasitic on *Lixus musculus* Say (Crawford 1907b. 180) and has been bred frequently from *Lixus scrobicollis* Boh.

Horismenus [*Holcopelte*] *producta* Ashm. was bred from *Laria* [*Bruchus*] *amica* Horn at Las Cruces, N. M. (Townsend 1895b).

Horismenus sp. have been bred as parasites of various species of Laria.

Asecodes albitarsis Ashm. is a secondary parasite on *Magdalis aenescens* Lec. (Chittenden 1900a. 37).

Secodes phloeotribi Ashm. is a secondary parasite on *Lixus musculus* Ol., *Pityophthorus minutissimus* Zimm. and *Chramesus icoriae* Lec. (Chittenden 1898. 48).

Entedon lithocolletidis Ashm. parasitizes *Anthonomus nigrinus* Boh. (Chittenden 1895. 350).

Eulophidae. Entedoninae. Pediobiini.

Eriglyptus robustus Cwfd. was described from *Anthonomus nigrinus* Boh. (Crawford 1907b. 180).

Eulophidae. Tetrastichinae. Tetrastichini.

Tetrastichus sp. attacks *Orthoris crotchii* Lec. (Pierce 1907, 1908).

Tetrastichus sp. attacks *Bracon nuperus* Cr. the parasite of *Orthoris crotchii* Lec. (Pierce 1907).

Mymaridae. Mymarinae. Anaphini.

Anaphes conotracheli Gir. was described as an egg parasite of *Conotrachelus nenuphar* Hbst. (Girault 1905. 220).

Hymenoptera. Ichneumonoidea.

Ichneumonidae. Cryptinae. Phygadeuonini.

Stiboscopus brooksi Ashm. was described as a parasite of *Craponius inaequalis* Say. (Brooks 1906. 240).

Ichneumonidae. Pimplinae. Pimplini.

Pimpla pterelas Say is recorded as parasitic on *Mononychus vulpeculus* Boh. (Harrington 1891).

Pimpla inquisitor Say is also recorded from the same weevil (Hamilton 1894).

Ephialtes irritator Fabr. has been bred from *Cryptorhynchus lapathi* Linn. (Jülich 1887).

Ichneumonidae. Ophioninae. Porizonini.

Porizon conotracheli Riley is recorded from *Conotrachelus nenuphar* Hbst. (Riley and Howard 1890. III. 156).

Braconidae. Euphorinae.

Cosmophorus hopkinsii Ashm. is recorded from *Polygraphus rufipennis*, and *Pityophthorus* sp. (Hopkins 1899).

Euphorus phloeotribi Ashm. is a parasite of *Phloeotribus frontalis* (Chittenden 1893b. 249).

Braconidae. Helconini.

Helcon ligator Say is parasitic on *Eccoptogaster* [*Scolytus*] *muticus* Say (Hopkins 1892. 259).

Braconidae. Blacinae. Calyptini.

Calyptus tibiator Cr. is a parasite of *Ampeloglypter sesostris* Lec. (Webster 1900) and *Anthonomus signatus* Say (Chittenden 1893a. 181).

Braconidae. Sigalphinae.

Sigalphus canadensis Prov. is recorded as parasitic on *Anthonomus scutellatus* Gyll. (Gillette 1890. 280).

Sigalphus copturi Riley is a parasite of *Podapion gallicola* Riley or its guest *Cylindrocopturus longulus* Lec. (Riley and Howard 1890. II. 353) and also of *Conotrachelus posticatus* Boh. (Pierce 1907b. 275).

Sigalphus curculionis Fitch is the common parasite of *Conotrachelus nenuphar* Hbst. and also attacks *Conotrachelus elegans* Boh. commonly at Dallas and Victoria, Texas. It is recorded from *Anthonomus grandis* Boh. (Hunter and Hinds 1904. 106), *Trichobaris trinotata* Say (Chittenden 1902) and *Conotrachelus juglandis* Lec. (Pierce 1908a. 43). The last record is based on specimens seen in the National Museum.

Sigalphus zygobaridis Cwfd. is typically parasitic upon *Zygobaris xanthoxyli* Pierce (Pierce 1907b. 289).

Sigalphus sp. is recorded from *Chalcodermus aeneus* Boh. (Howard 1894. 280).

Urosigalphus anthonomi Cwfd. was formerly referred to as *U. robustus* Ashm. in accrediting it to the boll weevil (Hunter and Hinds 1904. 107). It is described from *Anthonomus grandis* (Crawford 1907a. 133).

Urosigalphus armatus Ashm. is a parasite of Balaninus (Chittenden 1904. 33). Specimens seen in the National Museum from West Virginia were bred from a Conotrachelus in nuts.

Urosigalphus bruchi Cwfd. was described from *Laria prosopis* Lec. (Crawford 1907b. 181). It also attacks the Laria in *Vachellia farnesiana* pods, and *Spermophagus robiniae* Sch.

Urosigalphus schwarzi Cwfd. was described from the boll weevil, *Anthonomus grandis* in Guatemala (Crawford 1907a. 134).

Braconidae. Cheloninae.

Phanerotoma tibialis Hald. is very doubtfully to be credited as a parasite of *Anthonomus nigrinus* Boh. (Chittenden 1895. 350).

Braconidae. Agathidiinae. Microdini.

Microdus simillimus Cr. is possibly a parasite of *Lixus scrobicollis* Boh. (Hopkins 1892. 259).

Braconidae. Braconinae. Braconini.

Glyptomorpha lixi Ashm. is recorded from *Lixus scrobicollis* Boh. (Hopkins 1892. 256).

Glyptomorpha mavaritus Cr. is recorded from the same weevil in the same reference.

Glyptomorpha novitus Cr. attacks *Lixus musculus* Say (Pierce 1907b. 261).

Glyptomorpha rugator Say is a common parasite of *Lixus concavus* Say (Chittenden 1900b. 61) and *Lixus musculus* Say (Pierce 1907a. 43). It also attacks *Lixus scrobicollis* Boh. (Pierce 1907b. 261).

Vipio belfragei Cr. is parasitic on *Lixus scrobicollis* Boh. (Hopkins 1892. 256).

Melanobracon simplex Cr. attacks *Dendroctonus piceaperda* Hopk. (Currie 1905. 82).

Microbracon nuperus Cr. is parasitic on *Orthoris crotchii* Lec. (Pierce 1907a. 44).

Bracon analcidis Ashm. was described from *Tyloderma fragariae* Riley (Ashmead 1888. 619).

Bracon anthonomi Ashm. was described from *Anthonomus signatus* (Chittenden 1893a. 182).

Bracon mellitor Say the common parasite of *Anthonomus grandis* attacks also *Anthonomus albopilosus* Dietz (Pierce 1907b. 270, 271), *A. eugenii* Cano (Pratt 1907), *A. fulvus* Lec., *A. squamosus* Lec. (Pierce 1907a. 41, 43), *Craponius inaequalis* Say (Brooks 1906. 240), *Desmoris scapalis* Lec. (Pierce 1907b. 263). It has been bred by Fred M. Brooks from *Conotrachelus nenuphar* Hbst. and at Washington and Dallas from *Tyloderma foveolatum* Say. *Bracon* (*xanthostigma* Cr.) is recorded from *Laria* [*Bruchus*] *fratercula* Horn (Baker 1895).

Bracon pissodis Ashm. parasitizes *Pissodes strobi* Peck (Riley and Howard 1890. 348).

Bracon rhyssemati Ashm. MS. was bred from *Rhyssematus lineaticollis* Say (Pierce 1908a. 44), at Detroit, Mich., July 24, 1889, by F. M. Webster.

Bracon scolytivorus Cr. is a parasite of *Eccoptogaster quadrispinosus* Say (Packard 1890. 295).

Bracon smicronygis Ashm. MS. was bred from *Smicronyx tychoides* Lec. (Riley and Howard 1890. II. 350).

Bracon strobi is mentioned by Hopkins as a parasite of *Tomicus pini* Say (1892. Div. Ent. bul. 37. 120).

Braconidae. Rhogadinae. Rhyssalini.

Rhyssalus pityophthori Ashm. is parasitic on Pityophthorus (Pierce 1908a. 44).

Braconidae. Spathiinae. Hormiini.

Heterospilus [*Caenophanes*] sp. is recorded from *Laria bisignata* Horn (Riley and Howard 1893. 286).

Heterospilus pityophthori Ashm. MS. is a parasite of *Pityophthorus carniceps* Lec. (Hopkins 1899).

Heterospilus [*Caenophanes*] *spermophagi* Ashm. attacks *Spermophagus robinii* Sch. (Wickham 1895).

Braconidae. Spathiinae. Spathiini.

Spathius abdominalis Riley attacks *Phloeosinus dentatus* Say (Riley and Howard 1890. 350).

Spathius brevicaudus Ashm. MS. is a parasite of *Dryocoetes autographus* Ratz. (Hopkins 1892. 258).

Spathius brunneus Ashm. is probably a parasite of *Eccoptogaster muticus* (Hopkins 1892. 257).

Spathius canadensis Ashm. is recorded from *Dryocoetes autographus* Ratz., *Magdalis olyra* Hbst., *Phloeosinus graniger* Chap., and *Tomicus sp.* (Hopkins 1892. 258).

Spathius claripennis Ashm. MS. is recorded from *Polygraphus rufipennis* (Hopkins 1892. 257).

Spathius trifasciatus Riley attacks *Eccoptogaster quadrispinosus* Say (Packard 1890. 294).

Spathius unifasciatus Ashm. MS. attacks the same species (Hopkins 1892. 258).

Braconidae. incert. sed.

Lysitermus sculpticida Ashm. MS. is also recorded from *Eccoptogaster quadrispinosus* (Hopkins l. c.).

List of Weevils Parasitized

In order to make the foregoing reference more applicable, the following list has been arranged. The inclusion of the Lariidæ (Bruchidæ) is on account of their close relationship to the Rhynchophorous series. Species of economic importance are given in **bold face type,** and species serving as co-hosts of boll weevil parasites are preceded by an asterisk (*).

Acanthoscelis acephalus Say.........	Catolaccus coeliodis Ashm.
***Ampeloglypter sesostris** Lec	Myiophasia aenea Wied.
	Neocatolaccus tylodermae Ashm.
	Calyptus tibiator Cr.
*Anthonomus aeneolus Dietz..........	Catolaccus hunteri Cwfd.
*Anthonomus albopilosus Dietz......	Cerambycobius cyaniceps Ashm.
	Catolaccus hunteri Cwfd.
	Catolaccus incertus Ashm.
	Bracon mellitor Say.
*Anthonomus aphanostephi Pierce	Catolaccus incertus Ashm.

*Anthonomus eugenii Cano	Pediculoides sp.
	Catolaccus hunteri Cwfd.
	Bracon mellitor Say.
*Anthonomus fulvus Lec	Catolaccus incertus Ashm.
	Bracon mellitor Say.
Anthonomus grandis Boh	Aspergillus sp.
	Cordyceps sp.
	Pediculoides (2) spp.
	Tyroglyphus breviceps Banks.
	Aphiochaeta nigriceps Loew.
	Aphiochaeta fasciata Fallen
	Aphiochaeta pygmaea Zett.
	Myiophasia aenea Wied.
	Ennyomma globosa Towns.
	Microdontomerus anthonomi Cwfd.
	Spilochalcis sp.
	Eurytoma tylodermatis Ashm.
	(Bruchophagus herrerae Ashm.)
	Perilampus sp.
	Cerambycobius cushmani Cwfd.
	Cerambycobius cyaniceps Ashm.
	Catolaccus near anthonomi.
	Catolaccus hunteri Cwfd.
	Catolaccus incertus Ashm.
	Sigalphus curculionis Fitch.
	Urosigalphus anthonomi Cwfd.
	Urosigalphus schwarzi Cwfd.
	Bracon mellitor Say.
*Anthonomus heterothecae Pierce	Eurytoma tylodermatis Ashm.
	Catolaccus hunteri Cwfd.
*Anthonomus nigrinus Boh	Catolaccus anthonomi Ashm.
	Catolaccus incertus Ashm.
	Entedon lithocolletidis Ashm.
	Eriglyptus robustus Cwfd.
	?Phanerotoma tibialis Hald.
*Anthonomus signatus Say	Catolaccus anthonomi Ashm.
	Catolaccus hunteri Cwfd.
	Catolaccus incertus Ashm.
	Calyptus tibiator Cr.
	Bracon anthonomi Ashm.
Anthonomus scutellatus Gyll	Sigalphus canadensis Prov.
*Anthonomus squamosus Lec	Eurytoma tylodermatis Ashm.
	Catolaccus hunteri Cwfd.
	Bracon mellitor Say.
*Anthribus alternatus Say	Microdontomerus anthonomi Cwfd.
*Apion decoloratum Sm	Catolaccus incertus Ashm.
*Apion griseum Sm	Catolaccus incertus Ashm.
*Apion rostrum Say	Cerambycobius cyaniceps Ashm.
*Apion segnipes Say	Eurytoma tylodermatis Ashm.
*Araecerus fasciculatus Woll	Cerambycobius cushmani Cwfd.
Attelabus rhois Boh	Omphale elongatus Ashm.

***Auleutes tenuipes** Lec.	**Eutrichosoma albipes** Cwfd.
	Catolaccus incertus Ashm.
Balaninus sp.	**Urosigalphus armatus** Ashm.
***Balaninus nasicus** Say	**Mylophasia aenea** Wied.
	?**Trichacis rufipes** Ashm.
(**Brachytarsus** Sch. 1833= **Anthribus** Forst. 1771.)	
(**Bruchus** Linn. 1767= **Laria** Scop. 1763.)	
Calandra oryzae Linn.	**Meraporus calandrae** How.
	Meraporus n. sp.
	Cerocephala elegans Westw.
Ceutorhynchus rapae Gyll.	**Omphale livida** Ashm.
Chalcodermus aeneus Boh.	**Eunyomma clistoides** Towns.
	Sigalphus sp.
Chramesus icoriae Lec.	**Secodes phloeotribi** Ashm.
Conotrachelus sp	**Urosigalphus armatus** Ashm.
***Conotrachelus affinis** Boh.	**Myiophasia aenea** Wied.
***Conotrachelus crataegi** Walsh.	**Cerambycobius cyaniceps** Ashm.
***Conotrachelus elegans** Boh.	**Cholomyia inaequipes** Bigot.
	Myiophasia aenea Wied.
	Sigalphus curculionis Fitch.
***Conotrachelus juglandis** Lec.	**Metadexia basalis** G. T.
	Cholomyia inaequipes Bigot.
	Myiophasia aenea Wied.
	Sigalphus curculionis Fitch.
***Conotrachelus nenuphar** Hbst.	**Cholomyia inaequipes** Bigot.
	Anaphes conotracheli Gir.
	Porizon conotracheli Riley.
	Sigalphus curculionis Fitch.
	Bracon mellitor Say.
Conotrachelus posticatus Boh.	**Sigalphus copturi** Riley.
***Craponius inaequalis** Say.	**Stiboscopus brooksi** Ashm.
	Bracon mellitor Say.
Cryptorhynchus lapathi Linn.	**Ephialtes irritator** Fabr.
Cylindrocopturus longulus Lec.	**Sigalphus copturi** Riley.
Dendroctonus piceaperda Hopk.	**Melanobracon simplex** Cr.
***Desmoris scapalis** Lec.	**Bracon mellitor** Say.
Dryocoetes autographus Ratz.	**Spathius brevicaudus** Ashm.
	Spathius canadensis Ashm.
Eccoptogaster muticus Say.	**Heleon ligator** Say.
	Spathius brunneus Ashm.
Eccoptogaster quadrispinosus Say.	**Bracon scolytivorus** Cr.
	Spathius trifasciatus Riley.
	Spathius unifasciatus Ashm.
	Lysitermes scolyticida Ashm.
Eccoptogaster rugulosus Ratz.	**Cheiropachys colon** Linn.
	Rhaphitelus maculatus Walk.
Epicaerus imbricatus Say.	**Sporotrichum globuliferum** S.
Hypothenemus eruditus Westw.	?**Cephalonomia hyalinipennis** Ashm.
Laria sp.	**Horismenus** sp.

Laria sp. in Lotus	Bruchophagus mexicanus Ashm.
*Laria sp. in Vachellia	Eurytoma tylodermatis Ashm.
	Cerambycobius bruchivorus Cwfd.
	Cerambycobius cushmani Cwfd.
	Cerambycobius cyaniceps Ashm.
	Urosigalphus bruchi Cwfd.
Laria alboscutellatus Horn	Bruchophagus mexicanus Ashm.
Laria amica Horn	Horismenus producta Ashm.
Laria bisignata Horn	Heterospilus sp.
Laria chinensis Linn	Pediculoides sp.
*Laria exigua Horn	Microdontomerus anthonomi Cwfd.
	Cerambycobius brevicauda Cwfd.
	Cerambycobius cyaniceps Ashm.
	Meraporus bruchivorus Ashm.
	Catolaccus incertus Ashm.
*Laria fratercula Horn	Bracon mellitor Say.
*Laria obtecta Say	Cerambycobius cyaniceps Ashm.
	Bruchobius laticollis Ashm.
Laria pisorum Linn	Bruchobius laticollis Ashm.
Laria prosopis Lec	Urosigalphus bruchi Cwfd.
Lixus concavus Say	Glyptomorpha rugator Say.
Lixus mucidus Lec	Neocatolaccus tylodermae Ashm.
*Lixus musculus Say	Eurytoma tylodermatis Ashm.
	Cerambycobius cyaniceps Ashm.
	Neocatolaccus tylodermae Ashm.
	Horismenus lixivorus Cwfd.
	Glyptomorpha novitus Cr.
	Glyptomorpha rugator Say.
Lixus parcus Lec	Neocatolaccus tylodermae Ashm.
*Lixus scrobicollis Boh	Lixophaga parva Towns.
	Eurytoma tylodermatis Ashm.
	Cerambycobius cyaniceps Ashm.
	Horismenus lixivorus Cwfd.
	Microdus simillimus Cr.
	Glyptomorpha lixi Ashm.
	Glyptomorpha mavaritus Cr.
	Glyptomorpha rugator Say.
	Vipio belfragei Cr.
Loganius ficus Schwarz	Cerocephala scolytivora Ashm.
*Macrorhoptus sphaeralciae Pierce	Eurytoma tylodermatis Ashm.
Magdalis aenescens Lec	Cheiropachys colon Linn.
	Dinotus sp.
	hyperpar. Asecodes albitarsis Ashm.
Magdalis armicollis Say	Eurytoma magdalidis Ashm.
	Rhaphiteles sp.
Magdalis olyra Hbst	Spathius canadensis Ashm.
Mononychus vulpeculus Boh	Pimpla pterelas Say
	Pimpla inquisitor Say
*Orthoris crotchii Lec	Eurytoma tylodermatis Ashm.
	Tetrastichus sp.
	Microbracon nuperus Cr.
	hyperpar. Tetrastichus sp.

Phloeosinus dentatus Say	Spathius abdominalis Riley.
Phloeosinus graniger Chap	Spathius canadensis Ashm.
Phloeotribus frontalis Ol	Secodes phloeotribi Ashm.
	Euphorus phloeotribi Ashm.
Phytonomus punctatus Fabr	Empusa sphaerosperma.
	Entomophthora phytonomi.
Pissodes strobi Peck	Bracon pissodis Ashm.
Pityophthorus spp	Cosmophorus hopkinsii Ashm.
	Rhyssalus pityophthori Ashm.
Pityophthorus cariniceps Lec	Heterospilus pityophthori Ashm.
Pityophthorus consimilis Lec	Cerocephala pityophthori Ashm.
Pityophthorus minutissimus Zimm	Secodes phloeotribi Ashm.
Platypus compositus Say	Isaria tomicii Lugger.
Podapion gallicola Riley	Sigalphus copturi Riley.
Polygraphus rufipennis Kirby	Cosmophorus hopkinsii Ashm.
	Spathius clavipennis Ashm.
Rhodobaenus tredecim punctatus Ill.	Habrocytus rhodobaeni Ashm.
Rhyssematus lineaticollis Say	Bracon rhyssemati Ashm.
(Scolytus auct.= Eccoptogaster Hbst. 1793.)	
Smicronyx tycholdes Lec	Eutrichosoma albipes Cwfd.
	Bracon smicronygis Ashm.
*Spermophagus robiniae Sch	Eurytoma tylodermatis Ashm.
	Cerambycobius cyaniceps Ashm.
	Urosigalphus bruchi Cwfd.
	Heterospilus spermophagi Ashm.
	hyperpar.? Horismenus popenoi Ashm.
***Sphenophorus parvulus** Gyll	Mylophasia aenea Wied. (Phasiodista metallica Towns.)
Sphenophorus robustus Horn	Mylophasia robusta Coq.
***Tachypterellus quadrigibbus** Say	Cerambycobius cyaniceps Ashm.
	Catolaccus hunteri Cwfd.
(Tachypterus Dietz 1891 preocc.= Tachypterellus Ckll. & Fall 1907.)	
Tomicus sp	Spathius canadensis Ashm.
Tomicus pini Say	Bracon strobi Ashm. ?
*Trichobaris compacta Casey	Pediculoides sp.
	Cerambycobius cyaniceps Ashm.
*Trichobaris texana Lec	Eurytoma tylodermatis Ashm.
	Cerambycobius cyaniceps Ashm.
***Trichobaris trinotata** Say	Sigalphus curculionis Fitch.
Tychius semisquamosus Lec	Tanaostigmodes tychii Ashm.
*Tychius sordidus Lec	Cerambycobius cyaniceps Ashm.
*Tyloderma foveolatum Say	Eurytoma tylodermatis Ashm.
	Cerambycobius cyaniceps Ashm.
	Catolaccus incertus Ashm.
	Bracon mellitor Say.
Tyloderma fragariae Riley	Bracon analcidis Ashm.
Zygobaris xanthoxyli Pierce	Catolaccus hunteri Cwfd.
	Sigalphus zygobaridis Cwfd.

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THE ANNUAL MEETING OF THE ENTOMOLOGICAL SOCIETY OF ONTARIO

The forty-fifth annual meeting of the Entomological Society of Ontario was held at the Ontario Agricultural College, Guelph, on November 5 and 6. The meeting was most enthusiastic and interesting, and was well attended. The late Dr. James Fletcher, the President, had for some time been working to make this the best meeting in the Society's history. His illness, which took an aggravated form just before the meeting, was the one disappointment in connection with the gathering. The Society has always counted a great deal on his genial presence and almost unfailing store of knowledge on all matters under discussion. Apart from this, however, the serious nature of his illness aroused grave apprehensions in the minds of the members.

The first afternoon was devoted almost entirely to a conference on "Some of the Chief Insect Pests of the Season." The first of these discussions was the Leaf-Blister Mite (*Eriophyes pyri*). This insect was reported from most of the fruit-growing districts of Ontario and in some localities was said to be very abundant. In discussing methods of control it was stated that though present last year in the College orchard, it had this year apparently disappeared entirely. This result was thought to be due to a spring application of lime-sulphur. Several speakers recommended the use of this wash or of kerosene emulsion, either in the fall or spring, as satisfactory remedies.

The Shot-hole Borer (*Scolytus rugulosus*) was the next pest discussed. Mr Cæsar gave an account of his observation last autumn on the ravages of this pest in cherry orchards in the Niagara district. He cited several cases where the beetles had attacked perfectly healthy cherry trees of both the sweet and sour varieties. Last year this attack began in August. This year, when in the neighborhood of St. Catherines, on June 10th, he discovered that the beetles were again very abundant and were attacking both diseased and healthy trees. The latter were already at this date thickly spotted with gum exudations and had evidently been attacked in May. Egg-laying, however, was still to some extent going on in weakened and badly diseased trees. Again this autumn the beetles have caused serious damage to both cherry and plum trees, and to a lesser extent to peach. Montmorency cherries are, however, exempt. The attack this fall began as last year in August, and continued for several weeks. The experience of the two seasons suggest: that the months of May and August are probably the times when fruit-growers in infested districts should

be on the look-out for these insects. Wherever badly infested dead or dying trees were cut down and burned last winter and the other trees thoroughly sprayed in the spring with lime-sulphur or an oil-wash, there was no damage this year until August, when swarms of beetles again appeared. The necessary breeding grounds were probably provided in the many dead trees to be found within a radius of a few miles. Dr. Felt cited cases of Scolytids having been reported migrating for several miles in large swarms. Something of this nature appears to be what has taken place in the Niagara district.

The Apple Maggot (*Rhagoletis pomonella*) occupied considerable attention. It is not, however, widespread in Ontario, and though present for several years in considerable numbers in Prince Edward County and several neighboring districts along the shore of Lake Ontario, it does not seem to have spread to any known appreciable extent during this time.

The Lesser Apple-Worm (*Enarmonia prunivora*) had been reported by several orchardists as doing much damage to their apples and a considerable amount of supposedly infested fruit had been forwarded to be examined. Only a small percentage, however, of the injuries could, with any degree of certainty, be charged against this insect. It seems, nevertheless, to be present to at least some extent in very many orchards in different parts of the province.

Another subject of much interest briefly discussed was the "Malformations of Apples and Pears due to Insects." Specimens of work of the Plum Curculio on Apples were exhibited and also of some unknown sucking insect on Snow apples from British Columbia. This injury, according to the sender of the fruit, had been warded off from his own orchard to a very large extent this year by the use of lime-sulphur, whereas the neighboring orchards where Bordeaux instead had been used were as severely attacked as last year. The cause of another class of distortion on apples and pears not uncommon in Ontario orchards was debated. Some attributed the irregular depressions and knotty appearance of such fruit to a culculio, others were just as firmly convinced that it was a sucking insect that was to blame. The discussion brought out very clearly the need of much further careful investigation of such injuries.

The Oyster-shell Scale (*Lepidosaphes ulmi*) was another topic. This is one of the worst pests in Ontario orchards. Farmers are at least aware of the need of combatting it. In addition to the common practice of using either a double application of whitewash on the trees in the fall or kerosene emulsion when the larvæ are running, a number of farmers in Ontario County claimed excellent results during the last two years from spring applications of Gillet's Lye.

Further pests briefly discussed were the Codling-moth, the Turnip and Pea Aphids, and a Leaf Hopper (*Empoasca* sp.) attacking the foliage of potatoes. Nothing of special interest in regard to the Codling-moth was reported. Its ravages this year have, as usual, been severe in unsprayed orchards and even in some sprayed orchards in the Niagara district.

The Turnip and Cabbage Aphis was reported from every part of the province, and has done unprecedented damage, especially to the turnip crop. The ordinary methods of control were recommended by some, but others believed that in a season like this no known means could keep these insects from spreading in countless numbers over turnip fields.

The Pea Aphis has done much damage, especially to late peas, whole fields of these having been destroyed. It was found that a very large number of the aphids, in some cases nearly 100%, were attacked and destroyed by a fungus disease that spread with great rapidity in some districts.

Mr. A. Gibson of Ottawa reported much damage to potatoes in the eastern part of the province from the attacks of a Leaf Hopper (*Empoasca* sp.) which seriously injured the foliage.

The chief speaker on the first evening was Dr. E. P. Felt of Albany, N. Y., who gave an illustrated lecture on "The Interpretation of Nature." The first part of the lecture was devoted to showing the work and habits of bark-boring insects. Many beautiful views made these points clear and revealed a most interesting field for insect study, and one new to most of the audience. In addition to the bark-borers many other kinds of insects of economic interest, especially to residents of towns and cities, were shown and their importance briefly pointed out. The lecture closed with an account of the House-fly as a source of danger to public health.

The morning and evening of the second day were devoted chiefly to the reading of a number of papers, mostly of a technical nature. Among those of an economic or popular character were the following:

"The Economic Importance and Food-Habits of American Cecidomyiidæ," by Dr. E. P. Felt, Albany, N. Y.; "Observations on the Sorghum Midge in Louisiana," by Mr. R. C. Treherne, Guelph; "Natural Enemies of Some Ontario Coccidæ," by Mr. A. Eastham, Guelph; "Parasite Work on the Gypsy and Brown-tail Moths in Massachusetts," by Mr. W. R. Thompson, Guelph; and "Some Beetle-haunts," by Mr. F. Morris, Port Hope.

In his paper on the Cecidomyiidæ, Dr. Felt discussed first a number of destructive genera and species, such as the Hessian Fly (*Mayetiola*

destructor), Wheat Midge (*Cecidomyia tritici*), Pear Midge (*Contarinia pyrivora*), Violet Midge (*C. violicola*), Sorghum Midge (*C. sorghicola*), Cotton Midge (*C. gossypii*), Box Elder Midge (*C. negundifolia*), and other still unnamed species attacking various plants. Attention was then called to several beneficial species, especially those of the genus *Aphidoletes*, which live on aphids. Towards the close of the paper, the interesting preferences in regard to food plants shown by Cecidomyiids were referred to. For instance, 39 species have been reared from Solidago, 28 from Salix, 16 from Aster, and 10 from Grape. The wide field for study in this great family of tiny insects was shown from the fact that there are already 700 American species known, representing 50 genera.

In his address on "Natural Enemies of Some Ontario Coccidæ," Mr. A. Eastham gave the results of a year's careful rearing and study of the chief enemies of the more common scales in the vicinity of Guelph, *viz.: Lepidosaphes ulmi, Eulecanium cerasifex, E. caryae, E. fletcheri, Pulvinaria innumerabilis*, and *Aspidiotus ostreaeformis*.

Each paper was followed by a discussion so far as time permitted.

At the evening meeting of this day, Professor W. Lockhead, of Macdonald College, St. Anne de Bellevue, Que., read a paper on "What Entomology the Farmer and Fruit-grower Should Know." He was followed by Dr. Fyles, of Levis, Que., with a popular address entitled, "The Farmer's Woodlot." Dr. Bethune then read a paper from Dr. L. O. Howard, of Washington, D. C., on "The Present Condition of the Work Connected with the Importation of Foreign Parasites of the Gypsy and Brown-tail Moth."

In this paper, Dr. Howard mentioned certain very important innovations made in the work the last year or so. These were as follows: (1) The laboratory has for greater convenience been removed to Melrose Highlands, Mass. (2) A man thoroughly equipped in the biology of his special group has been put in charge of each division of the work, so that now a Hymenopterous expert looks after the Hymenopterous parasites, a Dipterous after the Dipterous, and a Coleopterous after the Celeopterous. (3) In order that parasites shall leave Europe in a better condition to stand the ocean voyage and arrive in a good state at New York, a general laboratory depot has been established at Rennes, France, under a trained man. All shipments are looked over and properly packed by him and forwarded in the quickest and best way possible. (4) An agent has been sent to Japan, where parasites are known to keep the Gypsy Moth under complete control, and these insect allies are now arriving in large numbers. Not a few of them have already been colonized.

(5) Active winter work with parasites is being carried on. The parasites are secured from nests of Brown-tail Moths from Europe. These are bred in artificially heated rooms and fed upon native hibernating Brown-tail larvæ, the latter being fed upon vegetables obtained chiefly from greenhouses. (6) The eggs of Brown-tail Moths are being retarded in development by keeping them in cold storage until the arrival of egg-parasites from abroad. These readily oviposit and breed in such eggs. This and the preceding innovation permit of numerous generations of parasites being produced at times of the year otherwise impossible. The important predatory European beetle, *Calosoma sycophanta*, has been successfully reared and has established itself. Over 200,000 of the most active enemies of the Gypsy and Brown-tail Moths have been liberated this year under most favorable circumstances. At least 7 of the 57 species introduced are already known to have established themselves. Many others will, it is believed, soon be found to have done likewise. Dr. Howard considers the outlook more favorable than ever, and ultimate success certain.

The paper was greatly appreciated, and a vote of thanks to Dr. Howard, coupled with a statement of the Society's deep interest in and appreciation of this great work, was unanimously carried. A vote of thanks to Dr. Felt was also passed for his kindness in coming so far to attend the meeting and for the great assistance given by him in helping to throw light on the many difficult problems that arose during the discussions.

The evening meeting was concluded by a short account by Dr. Bethune of "The Insects in Ontario that had Attracted Notice During the Past Season."

L. CAESAR, *Ex-Secretary.*

JOURNAL OF ECONOMIC ENTOMOLOGY PUBLISHING CO.

The annual meeting of the stockholders of this company will probably be held Monday evening, December 28th, the precise time and place being announced at one or more sessions of the Association of Economic Entomologists. Members of the Advisory Board are hereby notified that it devolves upon them to nominate the elective officers.

E. P. FELT, *President.*
E. DWIGHT SANDERSON, *Secretary.*

TWENTY-FIRST ANNUAL MEETING ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Baltimore, Md., December 28, 1908

The twenty-first annual meeting of the Association of Economic Entomologists will be held in Baltimore, Md., on Monday and Tuesday, December 28 and 29, 1908. The sessions will open at 10 a. m. Monday at the Eastern High School, corner of Broadway and North Avenue. The afternoon session will begin at 1 p. m. and meetings will be held on the following day at the same hours. Arrangements will be made to hold a session Monday evening if it is necessary to do so in order to transact all the business.

Other Meetings

The American Association for the Advancement of Science and its affiliated societies will hold meetings throughout the week.

The American Association of Horticultural Inspectors will hold sessions at 8 p. m. Tuesday, Dec. 29, and at 9 a. m. Wednesday, Dec. 30.

The Entomological Society of America will meet Wednesday and Thursday, Dec. 30 and 31.

Railroad Rates

A railroad rate of one fare and three fifths for the round trip, on the certificate plan, has been granted by the Trunk Line Association, the New England Passenger Association (excepting via N. Y., Ont. and W. Ry., the Eastern Steamship Company and the Bangor and Aroostook R. R.), the Eastern Canadian Passenger Association, and the Central Passenger Association.

The Western Association has on sale revised one way fares in effect to Chicago, Peoria and St. Louis, with the understanding that persons can repurchase from these points and take advantage of any reduced fares that may be authorized therefrom. The fares to Chicago, Peoria and St. Louis from a large part of the Western Passenger Association territory are now on the basis of two cents per mile; hence, with the reduced fares from the three cities named, the net rate amounts practically to a rate of fare and three-fifths for the round trip. A rate of fare and three fifths has also been requested from the Southern and the Trans Continental Passenger Associations, but decisions have not yet been received.

The following directions are submitted for your guidance:

1. Tickets at full fare for the *going* journey may be secured within three days prior to, and during the first three days of the meeting. The advertised dates of the meeting are December 26, 1908, to January 2, 1909, consequently, you can obtain your tickets not earlier than December 23, 1908, and not later than December 28, 1908.

From points located at a great distance, from which it takes more than

three days to reach Baltimore, going tickets may be purchased on a date which will permit members to reach Baltimore by December 26, 1908.

2. Present yourself at the railroad station for ticket and certificate at least thirty minutes before departure of the train.

3. Certificates are not kept at all stations. If you inquire at your station you will find out whether certificates and through tickets can be obtained to the place of meeting. If not obtainable at your home station, the agent will inform you at what station they can be obtained. You can in such case purchase a local ticket thence, and there purchase through ticket and secure certificate to place of meeting. Be sure that, when purchasing your going ticket, you request a *certificate. Do not make the mistake of asking for a receipt.*

4. On your arrival at the meeting, present your certificate to Mr. F. S. Hazard, assistant secretary. It has been arranged that the special agent of the Trunk Line Association will be in attendance at the office of the Permanent Secretary, to validate certificates daily (9 a. m. to 6 p. m.) from Tuesday, December 29, 1908, to Saturday, January 2, 1909, both dates inclusive. *A fee of 25 cents will be charged at the meeting for each certificate validated.* If you arrive at the meeting and leave for home prior to the special agent's arrival or if you arrive at the meeting later than January 2 after the special agent has left, you cannot have your certificate validated and consequently you will not get the benefit of the reduction on the home journey. *No refund of fare will be made on account of failure to have certificate validated.*

If the necessary minimum is in attendance, and your certificate is duly validated, you will be entitled, up to and including January 6, 1909, to a continuous passage ticket to your destination via the route over which you made the going journey, at three-fifths of the limited fare.

Hotel Headquarters

The hotel headquarters of this Association and of the Association of Horticultural Inspectors will be at the Rennert Hotel, Saratoga and Liberty streets, where a rate of $1.50 a day and upwards, on the European plan, has been secured.

Special

The meeting at Baltimore will be the twenty-first annual meeting of this Association. A large number of members have signified their intention of being present and an excellent program is assured.

All members or other persons interested in entomology are urged to attend and to assist in making this the largest and most successful meeting in the history of the Association.

Program

Monday, December 28, 1908, 10 a. m.

Annual address of the President, by Dr. S. A. Forbes, Urbana, Ill.

Report of the Secretary.

Report of the Committee on Constitution, by J. B. Smith, New Brunswick, N. J.

Report of the Committee on National Control of Introduced Insect Pests, by Wilmon Newell, Baton Rouge, La.

Report of the Committee on Nomenclature, by Herbert Osborn, Columbus, Ohio.

Report of the Committee on Testing Proprietary Insecticides, by E. D. Sanderson, Durham, N. H.

Report of the committee appointed to attend the Annual Meeting of the American Association of Nurserymen, by T. B. Symons.

Report of the committee appointed to attend the Annual Meeting of the Society for the Promotion of Agricultural Science, by A. F. Burgess, Washington, D. C.

Miscellaneous Business.

Appointment of Committees.

Reading of Papers

"BIOLOGICAL NOTES ON MURGANTIA HISTRIONICA," by R. I. Smith, Raleigh, N. C.

Statement of observations and experiments made during 1908, with particular reference to egg-laying and number of broods and their relation to remedial measures. 15 minutes.

"PEMPHIGUS TESSELLATA FITCH." By Edith M. Patch, Orono, Me.

Items in regard to the life history heretofore unrecorded, including notes on migrants, true sexes and eggs. 10 minutes.

Adjournment.

Program

Monday, December 28, 1 p. m.

Discussion of the Presidential Address.

Reading of Papers

"THE ECONOMIC STATUS OF THE HOUSE FLY." By E. P. Felt, Albany, N. Y.

A discussion of the economic importance of this insect. 15 minutes.

"NOTES ON CRANBERRY PESTS." By H. J. Franklin, St. Anthony Park, Minn.

Notes on life histories of some of the insects concerned and some general observations on parasitism. 15 minutes.

"MEANS WHEREBY THE ECONOMIC ENTOMOLOGIST CAN ADVANCE APICULTURE." By E. F. Phillips, Washington, D. C. 15 minutes.

"A Method of Securing Apicultural Statistics." By Burton N. Gates, Washington, D. C.

Description of a method which has been successfully tried in Massachusetts. 10 minutes.

"Notes on Empoasca mali LeB." By F. L. Washburn, St. Anthony Park, Minn.

New facts concerning the life history of this insect. 15 minutes.

"Do We Need the Insectary?"

General Discussion, which will be opened by E. D. Sanderson, Durham, N. H.

"Relating to Parasites." By L. O. Howard, Washington, D. C.

Adjournment.

Program

Tuesday, December 29, 10 a. m.

Reading of Papers

"The Identity and Synonymy of a Few of Our Common Soft Scales (Coccidae)." By J. G. Sanders, Washington, D. C. 12 minutes.

"Notes on Photomicrography and Insect Photography." By J. G. Sanders, Washington, D. C. 5 minutes.

"Photomicrography of the Diaspinae." By R. A. Cooley, Bozeman, Mont.

Advantage of photographs over drawings; preparing the microscopical slides; camera lenses and illumination; plates, developer and exposure; prints. 15 minutes.

"The Importance of Proper Methods in Entomological Investigation." By F. M. Webster, Washington, D. C. 15 minutes.

"Additional Experiments with the Corn Field Ant (Lasius niger americanus)." By S. A. Forbes, Urbana, Ill. 15 minutes.

"Fumigation Dosage for Tomatoes and Cucumbers." By H. T. Fernald, Amherst, Mass.

Factors influencing the resistance of these plants to fumigation and the strength of gas under which satisfactory results can be obtained at different ages. 15 minutes.

"Experiments in the Control of the Codling Moth." By E. D. Sanderson, Durham, N. H.

A discussion of the recent experimental work in spraying for the codling moth. 15 minutes.

Adjournment.

Program

Tuesday, December 29, 1 p. m.

Reading of Papers

"TREE CRICKETS AND INJURY TO APPLE WOOD." By P. J. Parrott, Geneva, N. Y. **15 minutes.**

"THE DISTRIBUTION OF SAN JOSE SCALE IN IOWA." By H. E. Summers, Ames, Iowa.

Notes on localities and amount of injury at northern limit of scale in this region. 5 minutes.

"THE SELF BOILED LIME-SULPHUR WASH AS A SUMMER TREATMENT FOR THE SAN JOSE SCALE." By A. L. Quaintance, Washington, D. C. **15 minutes.**

"SUMMARY OF RESULTS OF FUMIGATION AND DIPPING EXPERIMENTS." By T. B. Symons, College Park, Md. **10 minutes.**

"DOES ARSENICAL SPRAYING INJURE APPLE TREES?" By E. D. Ball, Logan, Utah.

A review of Bulletin 131, Colorado Agricultural Experiment Station, with further evidence on the matter. 15 minutes.

"AN EXPERIMENT IN THE CONTROL OF CURCULIO ON PEACH." By E. P. Taylor, Mountain Grove, Mo.

Results of a remarkably successful experiment conducted in the Ozark peach belt in the control of *Conotrachelus nenuphar* Hbst. on peach by using a reduced formula of lead arsenate. 12 minutes.

"NOTES OF THE YEAR FROM NORTH CAROLINA." By Franklin Sherman, Jr., Raleigh, N. C. **10 minutes.**

"ENTOMOLOGICAL NOTES FROM GEORGIA." By E. L. Worsham, Atlanta, Ga. **10 minutes.**

"INSECTS OF THE YEAR IN IOWA." By R. L. Webster, Ames, Iowa. **10 minutes.**

Reports of Committees.

Miscellaneous Business.

Election of Officers.

Final Adjournment.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN OF THE ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

DECEMBER, 1908

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Reprints of contributions may be obtained at cost. Minor line figures will be reproduced without charge, but the engraving of larger illustrations must be borne by contributors or the electrotypes supplied. The receipt of all papers will be acknowledged.—Eds.

The successful completion of the first volume of the JOURNAL has been rendered possible only by the hearty co-operation on the part of all. The Business Manager and the Advertising Manager have both been obliged to put a large amount of time and energy into the enterprise. The hearty co-operation of all contributors and the readiness with which a number complied with requests, have materially lightened the burden of the editors. The JOURNAL, judging from the matter already published, has proved a most useful medium for the presentation of matter of great interest and importance to the practical or economic entomologist, though perhaps of only secondary value to the general public. The latter is true only because technical matters relating to biology and identity, while absolutely necessary to the establishment of correct methods of control, possess little significance to a man simply interested in protecting a crop. Furthermore, this serial affords a ready medium for the frank discussion and free criticism of results. This latter, so long as the ordinary rules of courtesy are observed, cannot but react in a most beneficial manner. This enterprise has also made possible the prompt publication of the Proceedings of the annual meeting. This in turn should lead to a desirable modification in at least certain of the papers, and result in the presentation at the meetings of a synopsis of extended contributions rather than the submission of numerous details requiring careful study and consideration prior to intelligent discussion. We trust that there will be more time than heretofore for the presentation of methods and principles, leaving the numerous details to be recorded in the published proceedings.

Obituary

DR. JAMES FLETCHER

The death of Dr. James Fletcher comes as a sense of personal loss to all who ever met him, and of the older American entomologists there are few that have not met him. And no one who ever came into any close contact with James Fletcher failed in deriving some benefit from that contact. Big in body and mind, he abhorred littleness of all sorts and would believe ill of no one until the èvidence was overwhelming. Thoroughly good-natured himself under all conditions, he brightened up all about him, and no meeting was dull where he had part in it. Practical in all things and impatient of indirection and complications, a few pertinent words from him would often straighten out a tangle and bring agreement where disagreement seemed inevitable.

Dr. Fletcher began his work in entomology as did so many of the generation now largely passed away, by field observations—as a collector in fact. The writer made his acquaintance by correspondence nearly twenty-five years ago, while he was yet in the Library of Parliament at Ottawa, and when, later we met personally at one of the meetings of the Entomological Club of the A. A. A. S., a friendship was formed that lasted so long as both lived.

But Dr. Fletcher was not an entomologist only--he was quite as much of a botanist and knew plants perhaps even better than he did insects; while few birds and other animals of his country were unfamiliar to him. He loved nature in all its aspects and his observations in the field were accurate and reliable.

A characteristic feature in his make-up was his ability to inspire enthusiasm and to carry conviction. People believed him and in him, and he justified their faith. No one less able than he could have accomplished in Canada the work that he did, and the extent of that work can scarcely be appreciated by any one who has not followed it step by step. In 1887 he became officially what he had been practically for some time before, Entomologist and Botanist to the Dominion, and his territory extended from Nova Scotia to Vancouver, with all the problems that such a range opened up.

And while demands upon him increased as the Experimental Farm developed, assistance was given slowly until he carried a burden that can never again be imposed upon any one man. Fletcher was never a systematist and his works are largely in his official reports and in the publications of the Entomological Society of Ontario. Conservative always, he was never backward in adopting approved practice.

James Fletcher

He made haste slowly and feared only to do that which might weaken the faith of his constituency in his honesty and the effectiveness of the practice recommended. His idea was to prove all things first and, so far as possible, recommend only from personal experience. The justification of his course so far as his constituency is concerned is the universal respect and regard in which he was held from Atlantic to Pacific. He encouraged collectors and students always and everywhere to the full extent of his ability; he assisted in founding such organizations as the Ottawa Field Naturalist's Club, and served as an officer in associations of all kinds. He was for a time Secretary and Treasurer of the Royal Society of Canada, and in the Entomological Societies in the United States he has presided over the Association of Economic Entomologists and the Entomological Society of America.

It is the function of others more closely associated with him to give biographical details and lists of papers: the present is a tribute to the man and his work.

Dr. Fletcher was born March 28, 1852, at Kent in England, and died November 8th, at Montreal, Canada, leaving a widow and two daughters.

J. B. Smith.

WILLIAM HARRIS ASHMEAD

We regret to note the decease of Dr. Wm. H. Ashmead at St. Elizabeth's Hospital, Washington, D. C., on October 17. Dr. Ashmead in his earlier days was deeply interested in economic entomology, while his labors of recent years have given him a commanding position among Hymenopterists. His numerous determinations have been of greatest value to all economic workers. The general esteem in which he was held is admirably expressed in the following resolutions:

Whereas, The Entomological Society of Washington has lost by death its former president, William Harris Ashmead; and

Whereas, Doctor Ashmead was one of the oldest members of the Society and had, by his extraordinary activity and genius in entomological investigations, especially of a systematic character, contributed very greatly to the interest of the meetings of the Society and to the importance of its publications; and

Whereas, His warm-hearted enthusiasm and his kindly, helpful character had brought him to occupy a high place in the affections of all of the members of the Society; therefore, be it

Resolved, That in the death of Doctor Ashmead the Society has suffered a very great loss; that the field of systematic entomology has been deprived of one of its most prominent workers, and that the

development of that branch of science not only in this country but throughout the world will be retarded by his untimely end; and be it further

Resolved, That the members of the Society who loved and admired him will always profit by the memory of his indefatigable energy and his untiring effort to bring order out of the chaos of described and undescribed forms; be it further

Resolved, That a committee be appointed to prepare a sketch of Doctor Ashmead's life (including bibliography) for publication in the Proceedings of this Society, and that copies of these resolutions be sent, with an expression of sincere sympathy, to his family.

L. O. Howard.
Washington, D. C., October 19, 1908. E. A. Schwarz.
N. Banks.

ALEXANDER CRAW[1]

With the death of this remarkable man passes away another prominent figure from the horizon of American horticulture and economic entomology. Few economic entomologists are better known and no one more favorably than was he during his life work. Few entomological workers passed through California without seeking out and making his personal acquaintance, and all were charmed with the man. His unvarying amiability has won for him a lasting abode in the heart of every one that knew him. By early training a capable and successful horticulturist, his indomitable love for plant life later led him to form the vanguard of a fight against horticultural enemies on a scale that was never undertaken before.

Alexander Craw was born in Ayr, Scotland, August 3, 1850. In 1873 he emigrated to California and after a two years' residence in San Diego, moved to Los Angeles, where he took charge of the famous Wolfskill orange grove. His early training stood him in good stead in the early days of California's growth as a horticultural center. His authority in matters horticultural was never questioned and his advice ever eagerly sought. Presently *Icerya purchasi*, which had preceded his arrival in California by about five years, threatened the destruction of the citrus industry. It is difficult to determine at present who started the movement which culminated in the introduction of *Novius cardinalis* from Australia into California by Albert Koebele in 1888. But it is certain that Mr. Craw was a powerful factor in that movement. Never in our conversation in the office did he credit himself with the conspicuous rôle, yet it is quite evident to me that his constant agitation of the matter before the California horticultural

[1] Haw. Ent. Soc. Proc. 2:24-26, 1908.

organizations, and the incessant pressure he brought to bear by means of these upon authorities in Washington was to a considerable degree responsible for Koebele's victorious mission. Once victory was achieved and that so completely and in such an unusual manner he was possessed with the idea of controlling all horticultural insect pests by means of their natural enemies.

About 1890 he was prevailed upon to accept the office of inspector and entomologist under the California State Board of Horticulture, a line of work not previously undertaken anywhere and in which he spent the remainder of his life. Always kindly, yet always firm in the performance of his duty, he stood for fourteen years like a rock at the Golden Gate and jealously guarded his adopted state from horticultural pests of the world. All opposition he swept aside with a smile, without making a foe or losing a friend. He was a keen observer, so that by 1891 we find him not only familiar with the common garden and orchard pests but describing a species of his favorite group, Hymenoptera Parasitica (*Coccophagus* [=*Aspidiotiphagus*] *citrinus*, Bull. 57, California State Board of Horticulture, 1891). His writings are not profuse, and are confined almost entirely to periodical reports, in which he aimed principally to enlighten his horticultural readers on their insect problems as he viewed them. In Bull. 4, Tech. Ser., Division of Entomology, U. S. D. A., he published a list of the Coccidæ which he found in course of inspection at San Francisco. A number of species and varieties named *Crawii* may be observed in catalogues of this family.

In 1904 he was induced to enter the service of the Hawaiian Board of Agriculture as Superintendent of Entomology and Inspector. This office he filled in the same efficient manner that he had carried on the work in California, proving of great benefit to Hawaii in the exclusion of dangerous insect pests, and resulting in a better quality of fruits and vegetables being shipped here. His devotion to duty had the better of discretion, so that when on October 11, 1907, he was overtaken by the serious illness which on June 28, 1908, terminated his life, it was largely the result of overwork.

JACOB KOTINSKY.

FRANCIS HUNTINGTON SNOW

We regret to record the death on September 28, of Dr. F. H. Snow, for many years head of the Department of Entomology and Chancellor of the University of Kansas from 1889 to 1901. A more fitting notice of Dr. Snow and his work will appear in a subsequent issue.

Reviews

Arsenical Poisoning of Fruit Trees, by WILLIAM T. HEADDEN, Colorado Agricultural Experiment Station, Bulletin 131, 1908, p. 1–28.

This bulletin is of particular interest to entomologists, since the writer submits evidence showing that under certain conditions at least, repeated applications of arsenical poisons may result in serious injury to the trunks and roots of fruit trees. It is probable that the injuries from arsenical applications recorded by the author have been caused, in large measure, by the alkaline elements of Colorado soils reacting upon the arsenical compounds and producing combinations deleterious to the welfare of the trees; nevertheless the subject is one of much importance to all economic entomologists and there should be a careful watch for the appearance of any such trouble in other sections of the United States.

The Catalpa Midge, by H. A. GOSSARD, Ohio Agricultural Experiment Station, Bulletin 197, 1908, p. 1–12.

The life history and work of *Cecidomyia catalpae* Comst. is discussed in detail. The author recommends cultivation, fertilization and close planting in order to overcome in a large measure injuries by this midge. He provisionally advises the application of kainit in May and June for the destruction of the larvæ in the soil. The value of this bulletin is greatly increased by an excellent series of original illustrations.

The California Grape Root Worm, by H. J. QUAYLE, California Agricultural Experiment Station, Bulletin 195, 1908, p. 1–26.

This is a detailed account of the European *Adoxus obscurus* Linn., a species working in a very similar manner to the eastern grape root worm, *Fidia viticida* Walsh. The life history and habits of this insect are given in detail and the value of the publication is much enhanced by a fine series of original illustrations. Remedial measures advised by the author are deep cultivation for the destruction of pupæ, the application of a strong arsenical spray for destroying the beetles or the employment of a beetle catcher.

The Grape Leaf Hopper, by H. J. QUAYLE, California Agricultural Experiment Station, Bulletin 198, 1908, p. 177–216.

This is an extended biologic and economic discussion of *Typhlocyba comes* Say, illustrated by an excellent series of original figures. The author concludes that the most satisfactory method of controlling this species is by the use of a screen cage, a wire covered device especially adapted for the capture of leaf hoppers.

Fumigation for the Citrus White Fly as Adapted to Florida Conditions, by A. W. MORRILL, U. S. Department of Agriculture, Bur. Ent. Bulletin 76, p. 1–73.

This bulletin gives the results obtained from two winters of experimentation on the white fly in Florida. There is an extended discussion of the conditions and chemicals necessary to obtain good results. The description of the equipment and its method of operation is exceedingly helpful. The large amount of

data condensed in a series of tables affords an excellent basis for estimating the dosage. The work of the past two years has demonstrated the practicability of solving this big insect problem of Florida and other citrus districts on the Gulf coast. The practical value of the bulletin is greatly increased by the excellent series of original illustrations. It can not but prove of great service to citrus growers. The author is to be congratulated upon having covered the subject in such a comprehensive manner.

A Few Orchard Plant Lice, by C. P. Gillette and E. P. Taylor, Colorado Agricultural Experiment Station, Bulletin 103, 1908, p. 1–48.

This bulletin gives in concise form the results of extended observations and experimentation upon a number of the more injurious plant lice occurring in orchards. Two well executed colored plates constitute an extremely valuable addition to this publication. The life history notes and the results secured with various insecticides will be especially valuable to the entomologist. An abbreviated edition of this publication without the colored plates has been issued by the station as Bulletin 134.

The European Elm Scale, by Samuel B. Doten, Nevada Agricultural Experiment Station, Bulletin 65, 1908, p. 1–34.

This bulletin gives a detailed biological account of *Gossyparia spuria* Mod. based on original observations. Its value is greatly enhanced by excellent reproductions from an extensive series of enlarged photographs and numerous drawings showing structural details. Experiments with lime-sulphur wash, kerosene emulsion and scalecide are discussed, the last named apparently giving the best results, though the author inclines strongly to recommend thorough spraying with a forcible jet of water just before the leaves begin to show and again in June before the young scale insects appear. This bulletin is an important contribution to our knowledge of this pest.

A Contribution to Our Knowledge of Insecticides, by C. T. McClintock, E. M. Houghton and H. C. Hamilton. A Reprint from the Michigan Academy Sci. 10th Report, 1908, p. 197–208.

This paper records the results obtained in a very suggestive attempt to standardize the insecticidal properties of a number of contact insecticides and to show the relationship existing between insecticidal, germicidal and toxical values. The authors conclude that there is not any close connection between the three and urge the importance of establishing standard tests for the accurate comparison of insecticides. They found in their work that the common bedbug was a most satisfactory insect for making comparative tests. They state that chemical standardization of contact insecticides is at present impossible, since two substances having essentially the same chemical composition may vary enormously in their insecticidal values. It is to be hoped that this paper will stimulate other investigations along similar lines.

Fungous Diseases of Scale Insects and White Fly, by P. H. Rolfs and H. S. Fawcett, Florida Agricultural Experiment Station, Bulletin 94, 1908, p. 1–17.

Climatic conditions in Florida are unusually favorable for the development of fungous diseases. The authors have in this bulletin given brief popular

accounts of several beneficial fungi living at the expense of scale insects and white fly. This bulletin contains an excellent series of original illustrations.

Hawaiian Honeys, by D. L. VanDine and Alice R. Thompson, Hawaii Agricultural Experiment Station Bulletin 17, 1908, p. 1–21.

This is a study of the physical and chemical composition of Hawaiian honeys in an effort to establish some standards for comparison with honeys from other parts of the world.

Dipping of Nursery Stock in the Lime-Sulfur Wash, by P. J. Parrott, H. E. Hodgkiss, W. J. Schoene, New York Agricultural Experiment Station Bulletin 302, 1908, p. 175–202.

The results of a series of experiments are given in some detail, the authors concluding that the dipping of nursery stock in the standard lime-sulphur wash for the purpose of destroying San José scale is of doubtful value. They advise the fumigation of trees with hydrocyanic acid gas.

Some Destructive Shade Tree Insects, by F. L. Washburn, Minnesota Agricultural Experiment Station Press Bulletin 33, p. 1–32.

This bulletin gives summarized, practical discussions of a number of the more injurious insects affecting shade trees, remedial measures receiving special attention. The bulletin is printed on an excellent grade of paper and the large series of original illustrations come out in a most gratifying manner.

Insects and Diseases of Vegetables, by Melville Thurston Cook and William Titus Horne, Estacion Central Agronomica de Cuba, Bulletin 12, 1908, p. 3–28.

Brief illustrated accounts of a number of injurious insects and fungous diseases affecting various crops. The value of this bulletin is greatly increased by a number of process illustrations, some of which are susceptible of considerable improvement.

Injurious Insects, by Fabian Garcia, New Mexico Agricultural Experiment Station Bulletin 68, 1908, p. 1–63.

This bulletin notices a large number of the more injurious insects and is designed in particular to meet the needs of gardeners, fruit growers and farmers. It is illustrated by numerous cuts, most of them being reproductions from various entomological publications.

Some Insect Enemies of Garden Crops, by R. I. Smith, North Carolina Agricultural Experiment Station, Bulletin 197, 1908, p. 1–64.

This bulletin consists of brief economic illustrated accounts of a large number of injurious insects, being especially adapted for the use of gardeners.

Caterpillars Injuring Apple Foliage in Late Summer, by E. Dwight Sanderson, New Hampshire Agricultural Experiment Station, Bulletin 139, 1908, p. 207–228.

This bulletin consists of a series of popular economic accounts of a number of the more injurious leaf feeders occurring in late summer. It is admirably illustrated by a series of mostly original figures.

Current Notes

Conducted by the Associate Editor

Professor JOHN BERNARD SMITH, state entomologist of New Jersey, passed his fiftieth birthday November 21. A fortnight prior he confided to a friend that he proposed to celebrate the event by calling a special meeting of the Brooklyn Entomological Society, of which he has always been an active member, and entertaining them at dinner, a surprise party. The news leaking out, action was taken by the three societies of the Metropolitan district, Brooklyn, New York and Newark. A joint committee arranged a surprise for Professor Smith at a dinner given in his honor at the Imperial Hotel, Brooklyn, on the evening of his birthday.

Fifty entomologists assembled. Charles W. Leng, president of the New York Entomological Society, acted as chairman of the meeting. R. F. Pearsall, president of the Brooklyn Entomological Society, and H. Wormspacher, president of the Newark Entomological Society, assisted. E. L. Graef, the veteran Brooklyn lepidopterist, acted as toastmaster. A silver loving cup, the gift of individual members of the three societies, was presented with fitting remarks by C. H. Roberts, the authority on aquatic Coleoptera, who, with Professor Smith, is a charter member of the Brooklyn Society. A stein, capacious enough for a draught by all those present, was sent by Dr. R. Ottolengui, the monographer of Plusia.

Among those present were Dr. Henry Skinner and Mr. Daacke of the Feldman Social, Philadelphia; Prof. R. C. Osburn of Columbia University; F. A. Lucas, chief of the museum of the Brooklyn Institute of Arts and Sciences; Wm. Beutenmuller and Mr. Muehler of the American Museum of Natural History; E. B. Southwick, entomologist of Central Park; Edward Moore, Brooklyn city entomologist; L. A. Best, president of the department of entomology of the Brooklyn Institute; G. P. Engelhardt, curator of the Brooklyn Children's Museum; Rev. J. L. Zabriskie, Geo. Franck, Jacob Doll, lepidopterist of the Brooklyn Museum, and J. J. Levison, forester of Prospect Park. The New Jersey Agricultural Experiment Station was represented by J. A. Grossbeck, E. L. Dickerson and H. H. Brachme.

Letters of congratulation came from Dr. L. O. Howard, Washington; Dr. E. P. Felt, Albany; Prof. W. M. Wheeler, Harvard University; Karl Fuchs, San Francisco; Prof. J. H. Comstock, Cornell University; Dr. William Barnes, Illinois, and many others.

The occasion was most pleasurable to all and Professor Smith was forced to admit that the testimony of his loving friends almost compensated for the crossing of the fiftieth year mark.

A. H. Kirkland, Superintendent for Suppressing the Gypsy and Brown Tail Moths, has, we learn through the press, resigned his position on account of ill health. Mr. Kirkland has been a most conscientious official and we feel that his resignation means a serious loss to the Commonwealth of Massachusetts, since it will be very difficult to fill the position he has made vacant.

Prof. Glen W. Herrick has resigned the office of State Entomologist of Mississippi and accepted the position of State Entomologist of Texas. Address, College Station, Texas.

Mr. R. W. Harned, who was Assistant Entomologist under Prof. Herrick, has been placed in charge of the entomological work in Mississippi.

Prof. C. E. Chambliss has resigned as State Entomologist of South Carolina and has accepted a position with the Bureau of Plant Industry, United States Department of Agriculture. He will have charge of rice investigations. Address, Washington, D. C.

Dr. E. V. Wilcox, who had charge of preparing data on entomological publications for the Experiment Station Record, has been appointed Director of the Hawaiian Agricultural Experiment Station at Honolulu, Hawaii. He is now in charge of the work there.

Mr. W. A. Hooker of the Bureau of Entomology is now in charge of the work formerly carried on by Dr. Wilcox for the Office of Experiment Stations. Address, Washington, D. C.

Prof. C. F. Adams, Professor of Entomology at the University of Arkansas, has, in addition to his present duties, been made Acting Director of the Agricultural Experiment Station and Acting Dean of the College of Agriculture of that institution, vice Prof. W. G. Vincenheller, resigned.

Mr. H. L. Viereck has accepted a position as Entomologist for the Parke, Davis Company, Detroit, Mich.

Mr. Jacob Kotinsky has been appointed Superintendent of Entomology by the Board of Commissioners of Agriculture and Forestry of Hawaii. The position was made vacant by the death of Alexander Craw.

Mr. D. H. Kuhns has been appointed assistant inspector under Mr. Kotinsky.

Mr. George G. Ainslee, a graduate of the University of Minnesota, and Mr. T. D. Urbahns, a graduate of the Colorado Agricultural College, are now employed by the Bureau of Entomology as Special Field Agents and are working on insects which affect cereal and forage crops.

Mr. J. B. Garret, Associate Entomologist of the Louisiana Agricultural Experiment Station at Baton Rouge, has been appointed Assistant Director of the North Louisiana Agricultural Experiment Station, Calhoun, La.

Prof. Carlos E. Porter, editor *Revista Chilena de Historia Natural*, Casilla 2352, Santiago, Chili, has recently written Dr. L. O. Howard that he is anxious to secure papers published in the last twelve or fifteen years on Acari, Longicorns, Centipedes, Hemiptera, Algæ, Fungi and Crustacea. He also states that specialists who may desire to study the collections in the newly formed Museum of Valparaiso will be allowed to do so under the following conditions: (a) Specialist to retain duplicates; (b) Specialist to return one male and one female determined; (c) Specialist to send typewritten diagnosis of new species for publication in the *Revista*. One hundred separates of each article will be furnished.

An examination made by Mr. J. C. Crawford of the United States National Museum of the work of the late Dr. W. H. Ashmead brings out the fact that he has described over 500 new genera and over 3,100 new species of insects.

Mailed December 15, 1908.

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ECONOMIC ENTOMOLOGY

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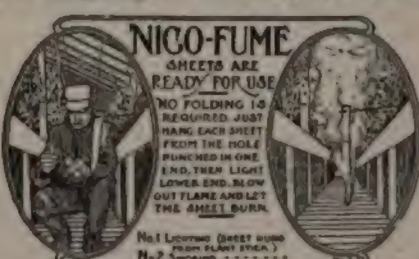

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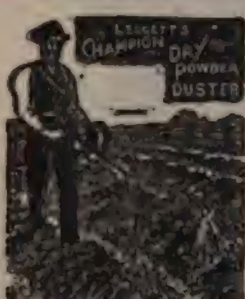

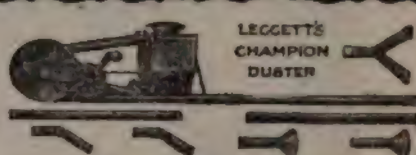

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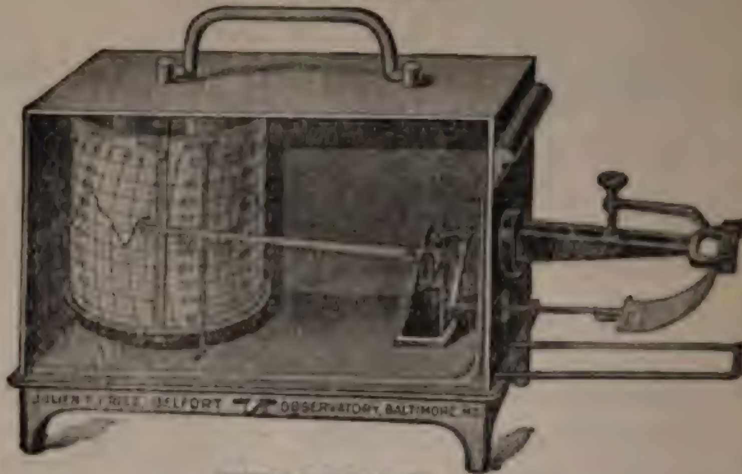

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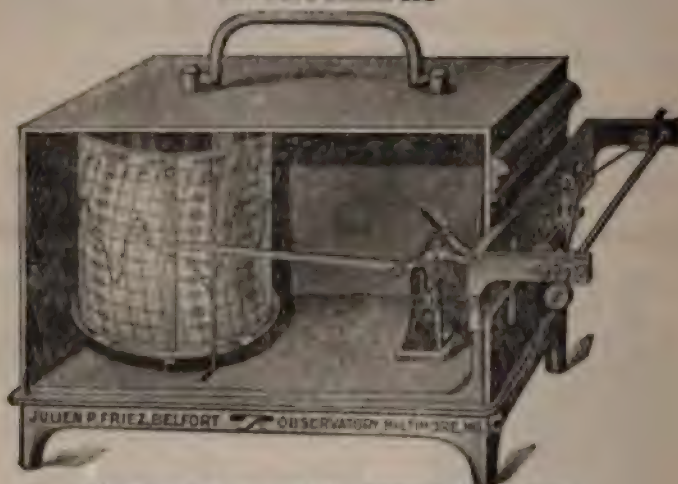

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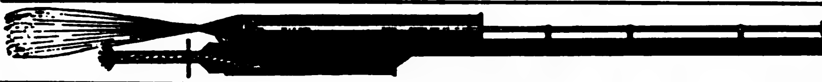

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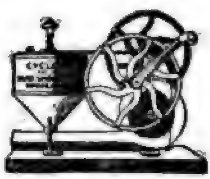

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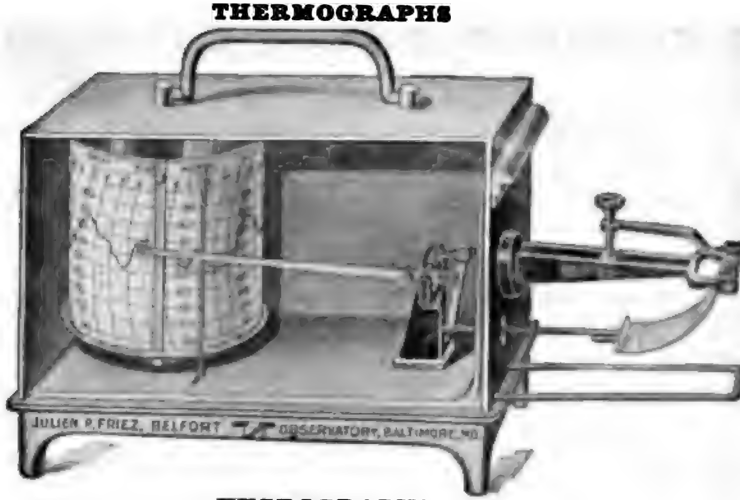

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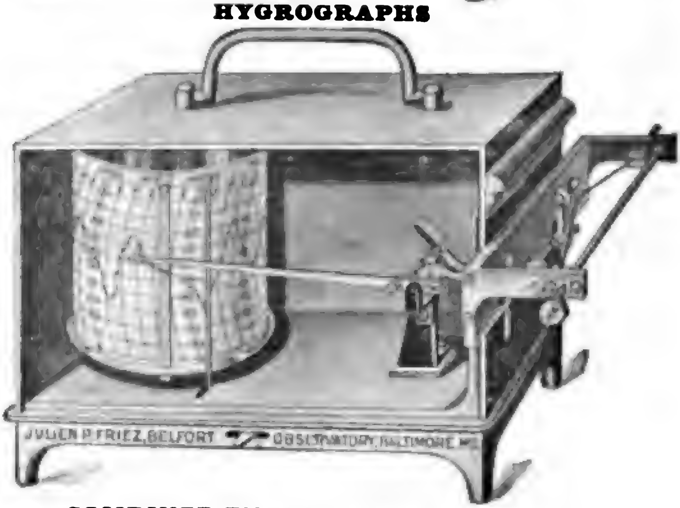

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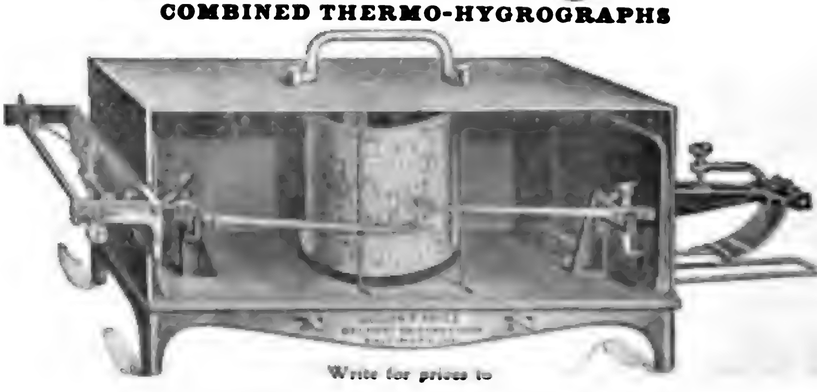

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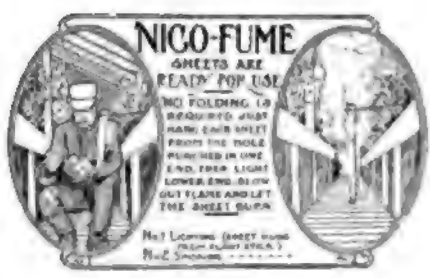

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